FILE
VCR-1

RCA

Video Cassette Recorder VHS

Model VBT200


VBT200

RCA Corporation
Consumer Electronics
Technical Publications
600 N Sherman Dr | Indianapolis, Indiana 46201

SAFETY CAUTION:

Before servicing this chassis, it is important that the service technician read and follow the "Safety Precautions" and "Product Safety Notices" in this Service Data.

Service Data Contents

Third Edition — First Printing

SAFETY PRECAUTIONS

Before returning any instrument to the customer a safety check of the entire VCR should be made. The service technician must be sure that no protective device built into the instrument by the manufacturer has become defective or inadvertently defeated during servicing.

Comply with all caution and safety related notes located on or inside the VCR cabinet and on the chassis.

WARNING: Alterations of the design or circuitry of this VCR should not be made.

Any design alterations or additions such as, but not limited to, circuit modifications, auxiliary speaker jacks, switches, grounding, active or passive circuitry, use of unauthorized camera, cables, accessories, etc. may alter the safety characteristics of this VCR and potentially create a hazardous situation for the user.

Any design alterations or unauthorized additions will void the manufacturer's warranty and will further relieve the manufacturer of responsibility for personal injury or property damage resulting therefrom.

Do not lubricate any motors. Use only authorized lubricants where lubricants are specified. If you lubricate, remove any excess lubricants.

When reassembling the VCR, always be certain that all the protective devices are put back in place, such as non-metallic control knobs, insulating fishpapers, adjustment and compartment covers/shields, isolation resistor capacitor networks, etc.

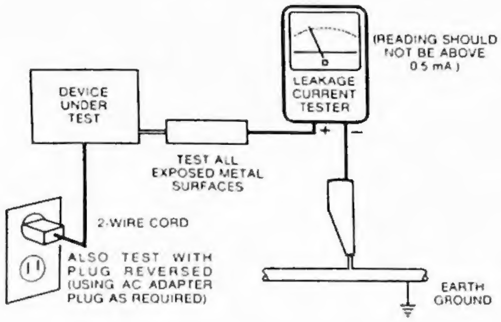
When service is required, observe the original lead dress. Components that indicate evidence of overheating or other electrical or mechanical damage should be replaced.

Antenna Cold Check

With the AC plug removed from the 120V AC source, place a jumper across the two plug prongs. Turn the instrument AC switch on. Using an ohmmeter, connect one lead to the jumpered AC plug and touch the other lead to each exposed antenna terminal screw and coaxial connector. The resistance measured should not be less than 1.0 megohm or greater than 5.2 megohms. Any resistance value below or above this range indicates an abnormality which requires corrective action. Repeat the test with the AC switch in the "off" position.

Leakage Current Hot Check (On Completely Assembled Instrument)

Plug the AC line cord directly into a 120V AC outlet (do not use an isolation transformer for this check). Use a Leakage Current Tester or a metering system which complies with American National Standards Institute (ANSI C101.1 "Leakage Current for Appliances") and Underwriters Laboratories (UL) 1410 (50.7). Measure for current with the AC switch "on" and repeat with the AC switch "off" from all exposed metal parts of the cabinet (antenna connections, handle bracket, metal cabinet, screwheads, metal overlays, control shafts, etc) to a known earth ground (waterpipe, conduit, etc.), particularly, any exposed metal part having a return path to the chassis. Any current measured must not exceed 0.5 milliamp. Reverse plug in the AC outlet and repeat test. ANY MEASUREMENTS NOT WITHIN THE LIMITS OUTLINED ABOVE ARE INDICATIVE OF A POTENTIAL SHOCK HAZARD AND CORRECTIVE ACTION MUST BE TAKEN BEFORE RETURNING THE INSTRUMENT TO THE CUSTOMER.



AC Leakage Test

AC Leakage Test

Avoid shock hazards. Do not connect this VCR to a TV antenna, cable or accessory that exhibits excessive leakage currents. If available, the television instrument or cable to which this VCR is connected should have the antenna cold check and the leakage current hot check performed.

Product Safety Notice

Many electrical and mechanical parts in VCR's have special safety related characteristics. These characteristics are often not evident from visual inspection nor can the protection afforded by them necessarily be obtained by using replacement components rated for higher voltage, wattage, etc. Replacement parts which have these special safety characteristics are identified in this Data and its Supplements and Bulletins. Electrical components having such features are identified by shading on the schematics and by (★) on the parts list in this Data and its Supplements and Bulletins. The use of a substitute replacement which does not have the same safety characteristics as the recommended replacement part shown in the parts list in this Data and its Supplements and Bulletins may create shock, fire or other hazards. Product Safety is continuously under review and new instructions are issued from time to time. For the latest information always consult the current RCA Service Data, Supplements and Bulletins. A subscription to, or additional copies of, RCA Service Data may be obtained at a nominal charge from your RCA Consumer Electronics Distributor or from RCA Technical Publications, 600 North Sherman Drive, Indianapolis, Indiana 46201.

SPECIFICATIONS

Power Input	120 Volts AC, 60 Hz
Power Consumption:	45 Watts
Operating Temperature:	5°C to 40°C (41°F to 104°F)
Storage Temperature:	-20°C to 55°C (-4°F to 131°F)
Weight:	17 Kg (37 lbs.)
Dimensions:	485 mm x 394 mm x 176 mm (19" x 15" x 7")
Video Recording System:	Rotary two-head helical scan system Luminance: FM recording Color Signal: Rotary phase converted sub-carrier direct recording.
Video Signal System:	EIA standard, NTSC color signals
Antenna Input Impedance:	VHF — 75 ohms UHF — 300 ohms
Video Signal Level:	1V p-p (140 IRE standard)
Audio Input Impedance:	-20 dB, 100K ohms
Audio Output Impedance:	-6 dB, 600 ohms
Audio Frequency Response:	Two hours -6 dB 100Hz — 8 kHz 3.33 cm/sec. (1.33 in/sec) Four hours -6 dB 100Hz — 6 kHz 1.67 cm/sec. (.69 in/sec)
Tape Speed:	Two hours 33.35 mm/sec. (1.3 in/sec) Four hours 16.67 mm/sec. (.65 in/sec)
Maximum Recording Time:	Four hours (VK250 in LP Mode)
Fast Forward Time:	4 minutes
Rewind Time:	4 minutes

GENERAL INFORMATION

The RCA VBT200 Video Cassette Recorder is a versatile instrument, having many features that are completely new to the servicing industry. The unit is not difficult to operate, and it is easily installed. External connections to and from the recorder are minimal, involving mostly intercept and reconnection of the television VHF and UHF antenna input leads. Necessary connecting cables, matching transformers, and adaptors are included to handle all but unusual installations.

1. A 5 foot, 75 ohm coaxial cable connects from the VHF out terminal on the recorder, to the VHF antenna input on the television receiver. Use cable direct if TV has 75 ohm input; use via 75 to 300 ohm matching pad if TV input is 300 ohm.
2. A 5 foot, 300 ohm flat twin lead connects the UHF out terminals on the recorder to the UHF antenna input on the TV receiver.
3. A 75 to 300 ohm matching pad is used for matching the 75 ohm VHF recorder output to a 300 ohm VHF input on the TV.
4. A 300 to 75 ohm connector/adaptor mates a 300 ohm, twin lead antenna system (outside or rabbit ear) to the recorder 75 ohm, VHF input system.
5. With a combination VHF-UHF antenna down-lead/splitter system, use this adaptor to convert the splitter 300 ohm twin lead to the recorders 75 ohm input connector. (Captive, screw-type lugs are integral to the unit strip and insert the lead wires, then tighten the screws.)

Keep in mind — for different or "odd" antenna systems — the VHF input and output of the VBT200 is 75 ohms, unbalanced; the UHF input and output is 300 ohms, balanced.

Antenna connection instructions should be carefully followed. The recorder produces an RF signal to be transmitted on VHF Channel 3 or 4 (switch selectable). If the recorder output is connected to an antenna (directly or in parallel from the TV terminals), the TV may broadcast a signal. Broadcasting an unauthorized signal could violate certain regulations of the Federal Communications Commission regarding the operation of RF devices. Recheck the installation to avoid any broadcasting possibilities; make sure the shielded lead is used to connect the RF output (VHF) of the recorder to the television set, and that no other connections are paralleled from these terminals.

The physical location of antenna "in" and "out" terminals are depicted in the rear apron photo of the VBT200 (Figure 1). "F" type connectors accept VHF input and output cables; post type connectors (with thumbwheel screw caps) serve for UHF twin lead.

The interface of the antenna system, recorder, and monitor television set is primarily controlled by a single pushbutton switch on the recorder — the TV/VCR input selector. Specifically, the switch system serves to distribute antenna input signals to either the television set VHF tuner or the VCR unit VHF tuner. A simplified schematic is shown in Figure 2.

The recorder VHF input contains a signal splitter; one path to the VCR tuner, the other to a section(s) of the TV/VCR switch. As a general rule, anytime the TV/VCR button is placed in the TV position, the recorder serves only to switch incoming VHF stations to the television set. Notice the other section of the TV/VCR switch terminates the output of the RF Converter (via R2). In the TV position, signal is also applied to the VCR VHF tuner; if power is applied to the recorder, the electronics shown in the blocks are operative, including the RF converter stage. However the RF output is disconnected (from the TV) and terminated via the switch and resistor.

Under the conditions shown in Figure 2 — switch in TV position — the television should operate in the normal fashion for both VHF and UHF reception. (UHF antenna signal distribution is via another splitter network inside the recorder; through the network, UHF is available to both the VCR UHF tuner, and the TV UHF tuner — the latter via the 300 ohm output terminals and connecting leads to the TV input.

Placing the TV/VCR selector switch in the VCR position shifts control of channel selection from the television to the recorder circuits and terminates the TV side of the VHF splitter via the switch and R1. The TV, when tuned to Channel 3 (or 4 as selected) now becomes a monitor for any VHF or UHF station selected with the recorder tuners. All incoming station signals (VHF and UHF) are processed through the TV demodulator in normal fashion, deriving output video and audio signals. These detected signals are coupled to the recorder for signal processing by appropriate record and playback circuits; monitor provisions of the selected signals are accomplished by electronics-to-electronics circuits (E-E) for application to the RF converter stage. Here, the signals are recombined, transmitted at Channel 3 (or 4) RF frequencies, and coupled via the TV/VCR switch to the VHF input of the television set. A two-position input selector — switch (S6303) — tuner/camera — is also shown in Figure 2. When placed in the camera position, incoming signal from the demodulator is disconnected, and the external camera video and audio input jacks located on the back of the instrument are active.

Many electromechanical safeguards are engineered into the unit, to prevent damage in case a "wrong function" is performed by the user. Function buttons for record/play/fast forward, etc., for example, are mechanically interlocked to prevent "invalid" change from one operating mode to another — without first returning to the "Stop" position.

Another safeguard senses any problem with tape transport operation and automatically activates "operation stop." If excessive moisture is detected in the proximity of the head cylinder, the "Dew" circuit prevents operation — and the amber light on the front panel illuminates.

INSTRUMENT REAR VIEW

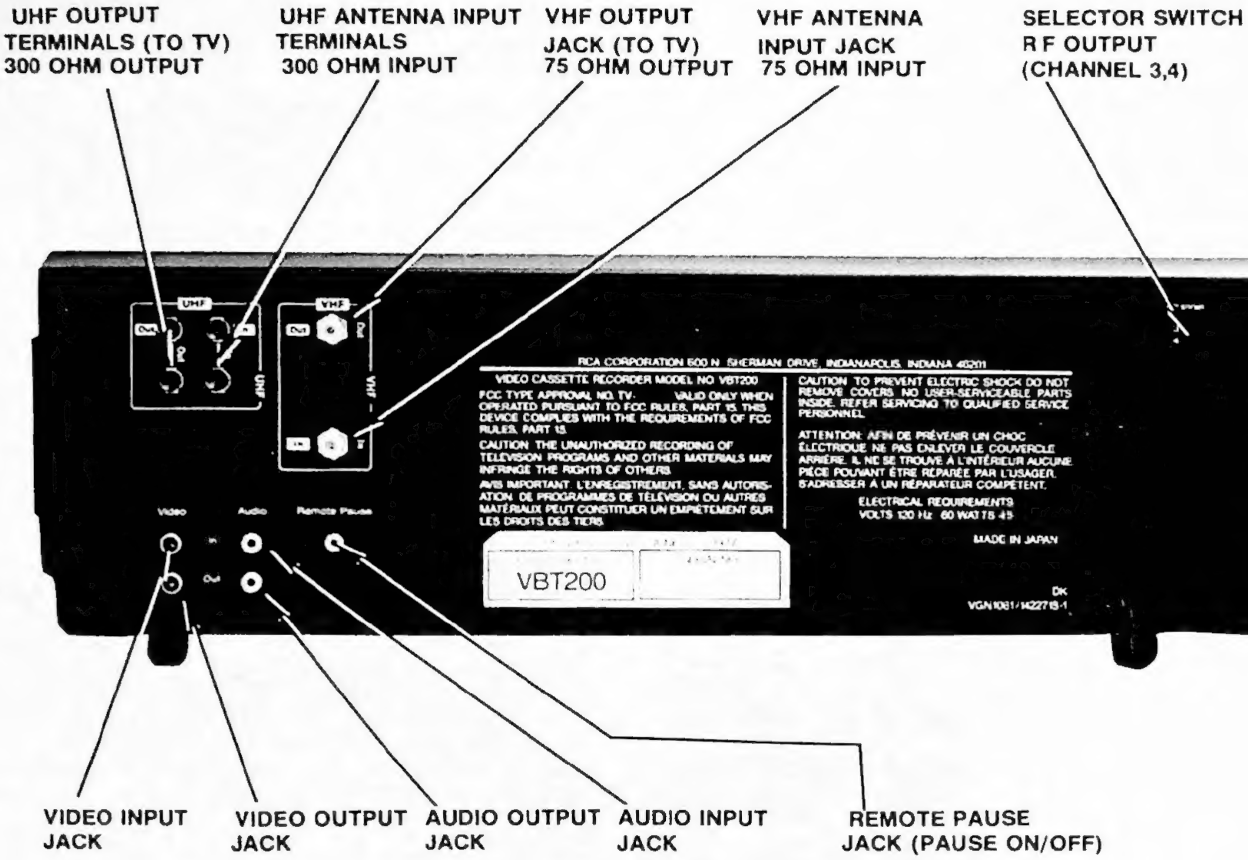


Figure 1. Rear View of VBT 200

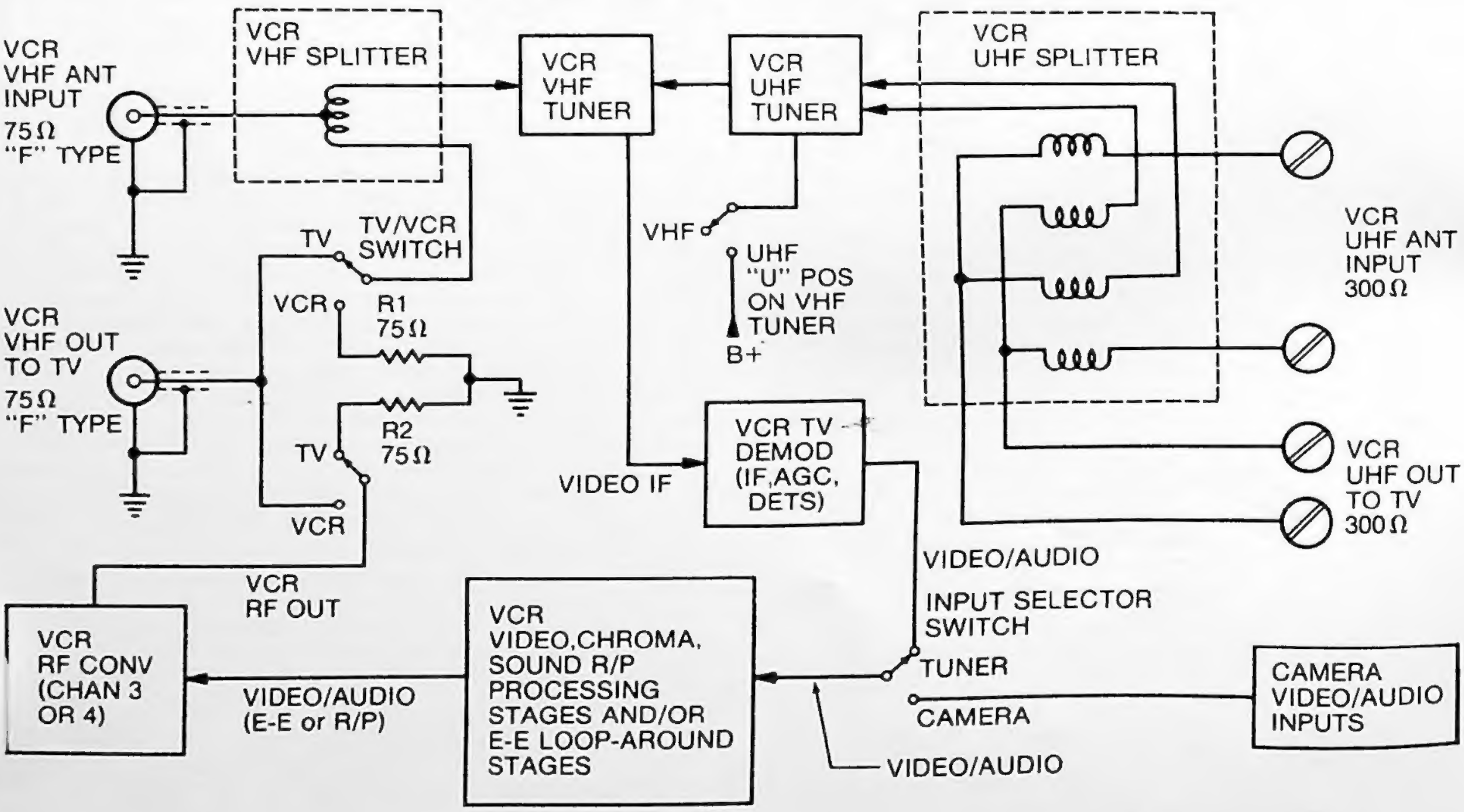


Figure 2. Simplified Schematic of TV/VCR Switch

OPERATING CONTROLS AND FUNCTIONS

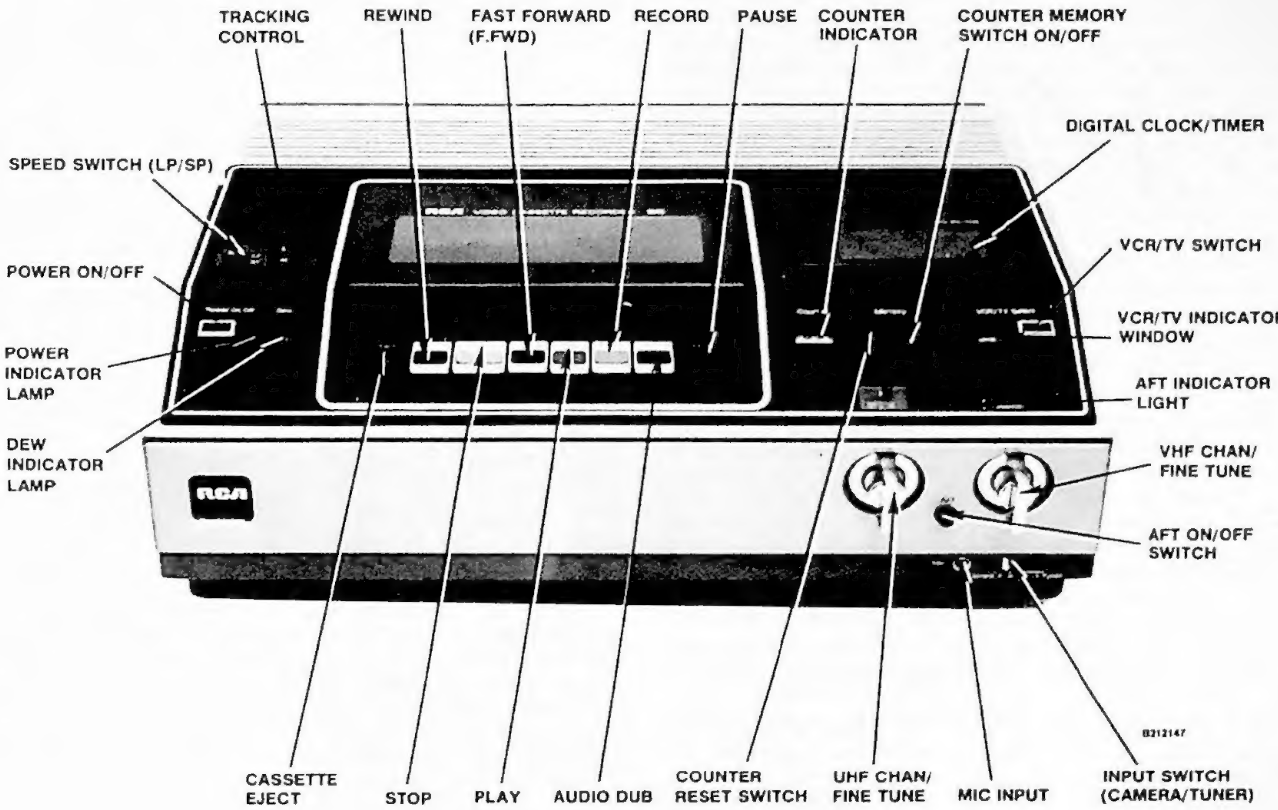


Figure 3. Operating Controls and Function Identification

OPERATING CONTROLS AND FUNCTIONS

Power On/Off

Power is applied to the instrument by pressing the on/off button; pressing the switch once again will remove power. A red indicator light illuminates in the "power on" mode; however, when the clock/timer system is engaged (placed in the timer position), and the power button is depressed, the indicator light will remain "off," until the timer circuit applies power at the preset "turn on" time.

Dew Indicator Lamp

In the event moisture is present in the proximity of the headwheel cylinder the instrument should not — in fact, cannot — be operated. Under these conditions, the Dew Indicator (amber colored light) will glow, and the recorder will not operate — until the moisture level is diminished. A cassette should be inserted, power applied, and the instrument permitted to "dry out," which takes approximately 1 hour — or until the Dew lamp extinguishes.

Speed Switch

The speed switch (S6309) is a two position toggle-type switch located on the top left side of the recorder.

The 2-hour mode is selected by placing the speed switch (labeled SP/LP) to the SP position for "standard play" time (1 hour with a VK125 cassette; 2 hours with the VK250 cassette). When placed in the "long play," LP position, time is extended to 2 or 4 hours with the respective cassettes. Proper selection of the SP/LP switch position is only necessary for the recording function. The proper playback speed is automatically selected via the electronics in the recorder (samples recorded "control track" on tape and automatically selects proper playback speed).

Tracking Control

A variable potentiometer for vernier adjustment of tape/head tracking is provided. The control is normally set to the center position, where a slight detent stop is provided. Adjustment of this control is rarely needed, when playing back a program material recorded to the individual VCR. The tracking control may require adjustment when a cassette is played, which was recorded on a different VCR. The visual indication of mistracking will appear as noise streaks in the picture and/or slight jitter. Merely turn the tracking control in one direction or the other (from center) to clear the picture interference. The control should be returned to its normal center detent position when play is completed.

Eject Key

This key is pressed to raise the tape cassette compartment to the "up" position for loading and/or unloading the cassette. A mechanical "lockout" system defeats the eject function in all operating modes other than the "stop" position.

OPERATING CONTROLS AND FUNCTIONS (continued)

Rewind Key

When the recorder is in the "stop" mode, pressing the rewind key will start tape movement from the takeup to the supply reel. Rewind will continue until the STOP key is manually depressed or the tape is completely rewound on the supply reel (left side of cassette). At this time, a transparent tape strip senses the tape end, and electronically activates the "stop" function — releases the rewind key. A preselected stop, programmed via the counter, is also possible. Placing the counter switch to its "memory" position will cause auto-stop when the counter reaches 999 — permitting selective use of the counter for program location on the tape (more information is given under Tape Counter). If rewind is desired from the play, record, or fast forward mode, the stop key must first be depressed before rewind will actuate.

Note: Always completely rewind the tape after playing or recording use is completed; tapes should not be stored in a partially rewound position for a prolonged period of time.

Stop Key

Pressing the STOP key initiates the unloading operation of the tape mechanism (assuming the VCR was in play or record position). This key should be pressed between any operation selection, and the mechanism permitted to halt completely before engaging another function. Several other sensors — some indicative of malfunctions, some normal conditions — cause "automatic stop" of the recorder. A transparent section of tape is on the start and end of the tape; a small lamp on the transport operates in conjunction with two (2) photocells, and "light transmitting cavities," within the tape cassette to engage end-of-tape stop circuits.

One photocell is located on the supply side of the transport; the other on the takeup side.

One activates the end of rewind, the other functions at the end of forward tape travel. Light from the lamp is blocked from both of the cells unless the transparent tape section — at the beginning or the end of the tape — allows light to be transmitted via the cavity to the appropriate photocell. This arrangement causes auto-stop at the start and end of the tape during rewind or forward operation.

Fast Forward Key

Pressing the FAST FORWARD key advances the tape at a rapid pace. Fast forward time from start to finish of the tape (VK250 cassette) takes approximately 4 minutes. Normal application of this mode is for fast access to desired program material (usually in conjunction with the counter), or to bypass some specific section of the material during playback. As with the rewind function, tape is not loaded. The tape is not in contact with the D.D. (Direct Drive) cylinder. Before the FAST FORWARD key can be depressed, it is necessary to first press the STOP key.

Play Key

The purpose of this key is self-explanatory, anytime Play is depressed, the recorded material on the tape is played back through the VCR electronics (including RF converter) to Channel 3 (or 4) on the television receiver. For playback, the TV/VCR switch must be in the VCR position. Anytime Play is selected, tape loading is actuated and the recorded material from the heads have priority over other inputs (in the VCR position).

Record Key

The RECORD key is pressed and held, then the PLAY key is pressed (down completely to the lock position) to start the recording process. Pressing the Record key alone does nothing.

Several facts should be remembered regarding the operation of the RECORD key:

1. If the play mode has been selected and play has started, the RECORD key is "locked out," and cannot be pressed — unless the Pause key is first depressed. This fact requires a word of caution. It is possible to start play, then press the PAUSE KEY AND THEN PRESS THE RECORD KEY. The result (if pause is released) is full erasure of the program material — usually not desirable except during editing operations.
2. If the erase-prevention tab on the cassette has been removed, the RECORD key (for that matter, the AUDIO DUB key, too) are locked out; pressing either key is impossible.

Audio Dub Key

Audio material from virtually any source can be added to prerecorded material. During camera recording, live audio is available via the built-in microphone in the camera. New audio may be inserted later, if desired, with an accessory microphone; or, background music from a phonograph, radio or tape recorder, inserted through the auxiliary audio input located on the rear of the instrument (Figure 1). Changing the audio portion of the video tape is accomplished by pushing the "PLAY" key and the "AUDIO DUB".

Note: The original audio track will be erased when the recorder is placed in the "Audio Dub" mode. However, the video information on the tape will not be affected.

Pause Key

The pause function can be activated manually (push key on unit), or remotely using the Remote Pause Control cable assembly. When pause is activated (only possible during playback or record), the "tape-unloading" operation is not activated; tape movement is halted, but the tape still maintains contact with the turning D.D. cylinder. For this reason, the pause function should only be used for short periods (10 minutes maximum); as excessive pause duration could cause tape abrasion.

As previously mentioned, the pause feature can be engaged in either the playback or record mode. Activating Pause in the playback mode mutes audio/video, interrupting signal to the television receiver. In the record mode, however, the E-E path is open, and program material is still viewable on the television receiver.

UHF Channel Selector

After placing the VHF channel selector to "U" position, the UHF tuner on the VCR is used to select and fine tune UHF stations — in a familiar manner. The outer knob is used for rapid movement of the tuning assembly until the desired channel number is aligned in the indicator window; the inner knob (knurled) is then used to fine tune the station.

With the TV/VCR switch in the VCR position, the UHF station tuned in on the recorder can be viewed on the monitor television Channel 3 (or 4), and/or recorded on the tape.

The UHF tuner is under control of automatic fine tuning circuitry (AFT) when the AFT switch is placed on.

VHF Channel Selector

VHF stations are also tuned in the familar fashion, using the outer knob to select the desired channel in the indicator window, then pushing in and adjusting fine tuning with the inner knurled knob. AFT should be placed in the off position until fine tuning is completed. As with UHF, with the TV/VCR switch in the VCR position, the selected VHF channel can be viewed and/or recorded.

Optimum reception of either VHF or UHF programs — for viewing or recording — depends on proper tuning of both the VCR and the television tuning system.

Automatic Fine Tune (AFT)

This instrument is equipped with AFT. The circuit is designed to correct the local oscillator frequency in the event of drift, thus preventing any signal tuning error.

Automatic fine tuning is placed in operation by pressing the AFT

OPERATING CONTROLS AND FUNCTIONS (continued)

button; visual indication of "AFT on" is provided by a green indicator lamp. Pressing the AFT button again, defeats AFT and extinguishes the light. During initial tuning adjustments, leave the AFT off until final station tuning is completed.

Mic Input

The microphone input receptacle accepts a standard mic-type plug; input impedance is 600 ohms. The MC-100 is the accessory microphone (optional) available for use with the VBT200. The MIC input finds application in conjunction with the audio dub feature when adding a new sound track; it also accepts microphone input when recording from a camera.

Tuner/Camera Input Selector Switch

The main purpose of this switch is selection of the signal source for recording. Unless a camera system is connected (with the camera video output connected to the VCR video input jack), and the switch placed in the CAMERA position, the recording source will be the VHF/UHF signals from the VCR tuning system.

If recording of video information from another source is desired — another video tape recorder, for example — apply the external signal to the video input jack, place the input selector switch to the CAMERA position, and proceed to record (video will appear on the monitor screen, and audio will be heard if applied via the external audio input jack. (These external input/output jacks are located on the rear of the recorder.

AFT Indicator Light

When the automatic fine tuning circuits are engaged (pushbutton in), this lamp will be lit.

TV/VCR Selector Switch

The primary purpose of this switch is to select the signal to be viewed on the monitor television. Specifically, the switch functions to distribute antenna input signals to either the television VHF tuner or the VCR VHF tuner. In the TV position, incoming station signals bypass the VCR electronics, being directed (via the VCR antenna splitter-distribution system) to the television receiver.

Note: The TV position does not defeat the recording capability of the VCR; off-the-air recordings can still be made, selected with the VCR tuner(s). This feature permits the capability of recording program material on one channel, while enjoying programs on another channel.

Tape Counter

The digital counter in the VBT200 indicates relative position of program material on the tape (if logged during recording or playback); this count is valuable for rapid relocation of material, end of material, amount of unused tape in the cassette, and translation to remaining record time on the cassette.

Memory Switch

Operating in conjunction with the digital counter system, the memory switch permits an automatic stop on rewind to be programmed. For instance, the counter can be set to 000 at the start of a recording at any section on the tape by pressing the reset button. Place the memory switch in the "on" position.

After the recording is completed, with the memory switch on, press rewind. The tape will rewind until approximately the 999 position is reached, then stop — very close to the start of the program just recorded. If further rewind is desired, merely press rewind again, and the tape returns to the tape start position. If the memory switch is off, and rewind started, the tape returns to the tape start position before auto-shutoff is activated by the "photocell" system.

Electronic Digital Clock/Time

A valuable built-in feature of the VBT200 recorder offers a time-of-day digital readout with AM/PM indication, and a programmable timer function. The timer permits unattended recordings to start at a pre-selected time. The timer will automatically switch the VBT200 on at the time selected; at the end of tape supply (unless manually shut off), the recorder will automatically shut off.

Please note these few particulars on the clock/timer unit: If the instrument power was interrupted, the AM or PM indicator will be flashing (if power has returned), requiring that the clock be reset to the correct time of day. When the timer function is engaged (via the timer on/off switch), a red indicator will light, and the clock will then indicate the timer preset time — not, the time-of-day. In the timer "on" condition, power to the recorder is controlled by the timer system, the main recorder power indicator light will be off — even though the main power switch is in the "on" position. Under these conditions — timer on, main power switch on — the recorder cannot be manually operated; power is defeated via the timer — unless the time-of-day clock happens to match the preset time, or the user places the timer switch to the off position.

Three controls are involved when using the digital clock/timer for recording, namely; the timer on/off switch, one clock-set switch (two-position) for time of day, or auto set, and one clock-set switch (two-position) for "stepping" the digital clock fast or slow.

To Set The Clock:

1) Lift cover for access to controls.
2) Set the TIMER switch to "off."
3) Set the clock indicator switch to TIME-OF-DAY position, and
4) Hold ADVANCE switch in FAST position until within 15 minutes of desired time, then move to SLOW position until desired time is reached. Make sure AM or PM indicator is correct.

To Set The Timer:

1) Set the TIMER switch "off."
2) Set the clock indicator control to AUTO SET, and
3) Advance clock with FAST or SLOW switches in same manner as above to the desired time — the recording-start time desired, again checking the AM/PM indicator.

The time-of-day or auto set switch can be left in either position, and if the timer switch is on, power will be applied to the recorder when the time clock reaches the preset start time.

Remember, if the recorder is started by timer control, and the operation is interrupted manually, move the timer switch to off to restore full manual control.

PROGRAM RECORDING

Recording Television Programs

The built-in RF tuners and television demodulator stages permit the recording of program material from any VHF or UHF television channel, while viewing another channel. If desired, the same program being recorded can be viewed through the recorder electronics and monitor means via the RF converter: the television channel selector is tuned to either Channel 3 or 4 (as selected by the rear apron channel switch); the station then selected by the VCR tuner(s) is viewed and recorded.

Basically, the tuning procedure involves:

1. Apply power, tune television to Channel 3 (or 4), place TV/VCR Switch in VCR position; Camera/Tuner Switch in Tuner position.
2. Select station to be recorded with the channel selector on the recorder. Touchup fine tuning as necessary while viewing signal on TV receiver.
3. Start recording when desired, while viewing program being recorded.

PROGRAM RECORDING
(continued)

4. To watch a different channel (while recording the other), place TV/VCR Switch to TV position. Select the different channel to be viewed using the television controls.

Recording Camera Signals

Live video and audio recordings are possible using either of the optional cameras for the VBT200; both cameras have built-in microphones and remote power control for start-stop (via the pause function); pressing the camera switch controls the recording start-stop. If desired, a separate microphone can be used in lieu of the camera mike, by connecting to the MIC input jack on the front of the recorder. The MIC input can also be used after the original recording, in conjunction with the "Audio Dub" feature, to add a new audio track on the pre-recorded camera video; background music could be added, by the connection to the Audio Input jack located on the rear of the instrument. However, when the "Audio Dub" feature is used, any pre-recorded audio is erased.

Unattended Recording

The VBT200 is equipped with a built-in electronic digital clock/timer. This feature permits unattended recording at the time preselected by the timer function. The channel to be time-recorded is tuned in, necessary adjustments are performed, recording start time is set, and recording buttons set. When the timer clock reaches the predetermined time, the VCR will automatically turn on and start recording. Unless the recording is manually interrupted "shut off" will be automatic, sensed and activated by a transparent strip at the end of tape supply.

Extended Play/Record Time

The VBT200 Video Cassette Recorder has the capability for either 2- or 4- hours of continuous record or play. Two cassette tapes are available: the VK125 has sufficient tape for up to 2 hours of play/record; the VK250 cassette tape for up to 4 hours, assuming the long-play mode is selected.

CLEANING TAPE MECHANISM

Periodic cleaning is necessary to insure continuous excellent performance of the tape mechanism.

To clean the following parts use "Kim Wipes" and solvent (RCA Stock No. 144592):

1. Capstan shaft
2. Threading Post
3. Limiter Posts
4. Tape Posts
5. Pressure roller
6. All idler wheels
7. All belts
8. Supply and Take-up reels
9. Play roller
10. Rewind roller
11. Flywheel
12. All pulleys

To clean video heads, erase head and the audio control (A/C) head use only the head cleaning kit (RCA Stock No. 144589) and solvent (RCA Stock No. 144592). NOTE: When cleaning the video heads move the cleaning stick in the same direction of head rotation. Wiping in a vertical motion may damage the heads.

LUBRICATING TAPE MECHANISM

The tape transport mechanism is properly lubricated at the factory. In normal use cycles, and with average environmental conditions, additional lubrication should not be required during the first year of operation.

Depending on use and environmental conditions, periodic lubrication may be required. When relubricating, remove old lubricant first, then sparingly apply new lubricant. (Excessive lubricant may be transferred to other assemblies causing malfunction). Use only RCA Stock No. 144590 grease on the following parts after 1000 hours operation:

Loading base #69
Loading Motor Worm Wheel and Gear Surfaces #79.

RCA Stock No. 144591 oil may be required for the following parts every 1,000 hours.

Capstan Assembly #2
Pressure Roller #20
Rewind Arm Assembly #8
Play Arm Assembly #7
Takeup Reel Table #17
Supply Reel Table #18
Intermediate Pulley #16
Worm Wheel Metal Shaft #79
Supply Inertia (Impedance) Roller #53
Takeup Inertia (Impedance) Roller #60
Loading Gear Metal Shaft #79

Other parts which are not listed above do not require lubrication, except if part is replaced. Use appropriate oil or grease as indicated on section-six exploded views.

CLEANING/LUBRICATION — TUNERS

Manual Cleaning

Remove tuner from chassis and remove tuner shields. Clean the switch rotor and stator contacts with Chlorathene NU, using a 1/4" medium stiffness brush. Chlorathene is a nonflamable, nontoxic cleaner available at RCA distributors and other suppliers. Application of cleaner with vigorous brushing will remove both dirt and previous lubricants. The tuner switches should not be rotated until after sufficient drying time for the cleaner and relubrication.

Careful visual inspection should be made during and after cleaning to locate and repair loose, broken, or otherwise damaged contacts.

The following procedure is recommended for lubricating television tuners. Other lubricants and application methods are not recommended.

Required Lubricants

Antenna, R-F, Mixer and "Function" switch lubricants — use RYKON Grade O-EP manufactured by American Oil Co. (RCA Stock No. 143701).

Application of Lubricants

All switches (Antenna, R-F, Mixer, Oscillator and "Function") should be lubricated on all exposed surfaces of each rotor blade. Rotate the rotor six times in one direction; a reservoir of lubricant will exist between both jaws of contact clips and there should be a film of lubricant covering each rotor blade.

The shaft assembly should be lubricated with RYKON O-EP at front and rear of tuner.

VBT200 CIRCUIT DESCRIPTIONS

The model VBT200 Video Cassette Recorder utilizes the VHS (Video Home System) recording format. This system incorporates several advances in home video recording to deliver excellent performance and high reliability.

The mechanical configuration of the VBT200 is highlighted by use of a direct-drive upper cylinder (headwheel) assembly which is powered by a three-phase AC motor of advanced design. The combination of this motor and a low-mass headwheel assembly are the key to the system stability required for color television recordings of up to four hours. In addition, a very simple automatic tape threading system minimizes tape handling and helps assure long tape life. The mechanical operation of the VCR is controlled by the transport-control electronics circuitry. The remaining circuitry — power supply, signal processing, servo control and SP/LP switching — is the subject of this Operational Description section.

The block diagram (Figure 4) illustrates the various interrelationships among the several sections of the recorder. As shown, video output from either a television receiver type "front end" (TV tuners and TV demodulator) or a direct video input are applied to the recording circuitry. This circuitry consists of separate **luminance** and **chroma record** sections whose outputs are combined in the record amplifier and applied to the video heads.

During playback, the recorded signal from the tape is applied to separate **luminance** and **chroma** playback sections after passing through preamplifier circuitry. The output of these circuits is combined in a video amplifier, whose output is applied to an RF converter. This converter remodulates the video information on either Channel 3 or 4, allowing the playback video and sound to be viewed on a television receiver. A section of the circuit (not shown) samples input video in the record circuit and couples it to the RF converter via part of the playback video amplifier. This configuration called **E-E Mode** (Electronics-to-Electronics Mode), allows the user to monitor the video program being recorded.

Headwheel and tape transport speed control is provided by two separate servo systems called the **Cylinder (Headwheel)** and **Capstan Servo** systems. The cylinder servo system receives reference signals from either vertical sync during recording, or from a master 3.58-MHz oscillator (counted down to 60 Hz) during playback. These signals are compared against pulse-generator (PG) sample pulses (represent the position of the heads) to maintain the exact headwheel speed and position phasing required. Also, during recording, pulses which represent vertical sync are recorded by the control head along the bottom edge of the tape. These serve to synchronize the capstan servo system during playback.

The capstan (tape transport) servo system references instantaneous headwheel position signals against a sample of capstan motor speed frequency-generator (FG) signals to maintain constant tape transport speed during recording. During playback, the instantaneous headwheel position information is referenced

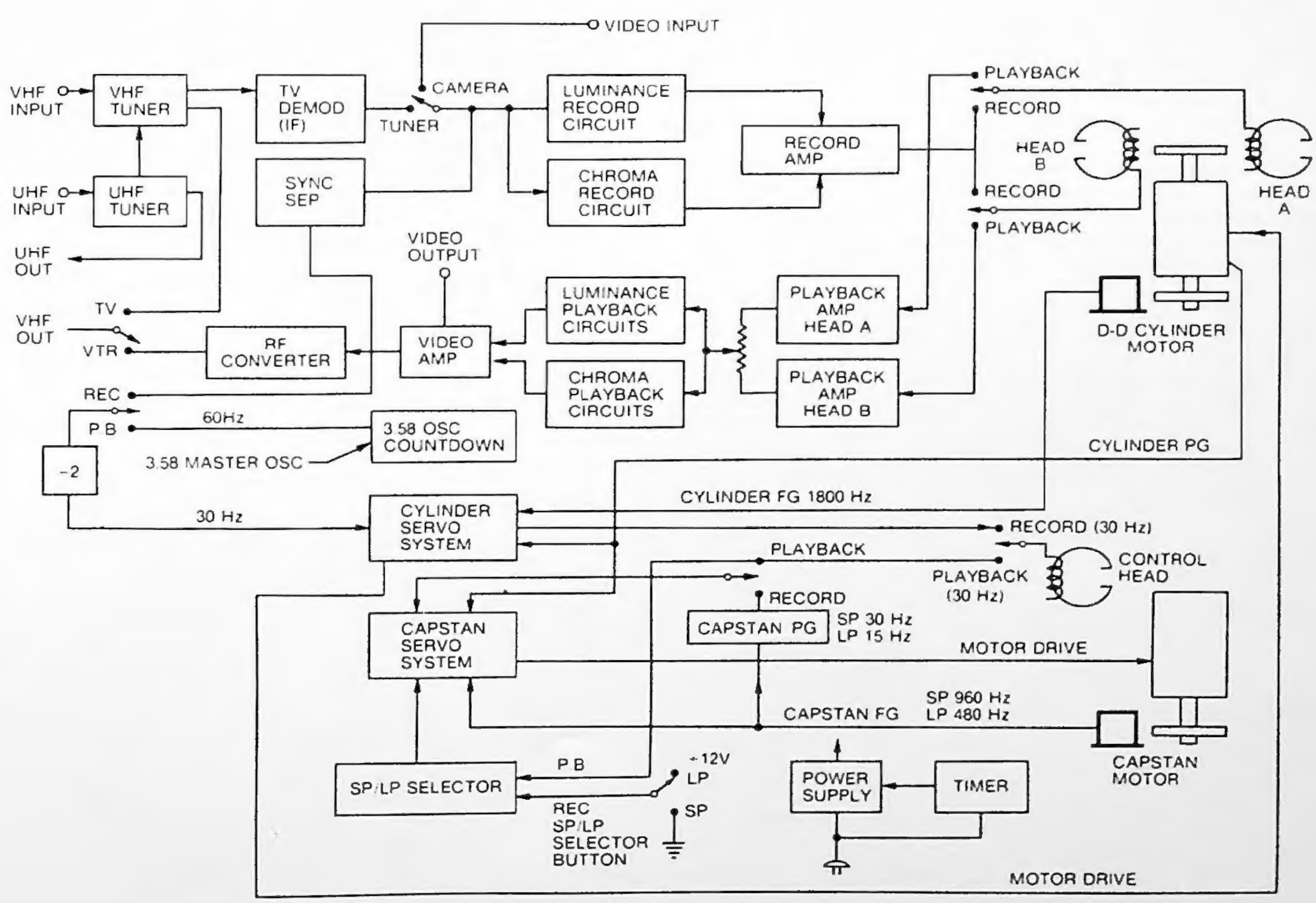


Figure 4. VBT200 Overall Block Diagram

VBT200 CIRCUIT DESCRIPTIONS (continued)

against the control track output signals to provide minute adjustments of capstan speed. In this manner, the tape transport speed is dynamically adjusted to assure that the rotating heads properly align with the recorded video tracks.

The user selects 2-Hour (SP) or 4-Hour (LP) recording modes which determines transport speed during recording. The **SP/LP Selector Circuit** automatically determines the correct transport playback speed by sampling the control track pulse rate.

The **Power Supply Circuitry** converts standard 120V AC 60-Hz line power into three DC supplies for use by the recorder. Power consumption is 45 watts.

POWER SUPPLY CIRCUITS

The VBT200 Video Cassette Recorder power supply (Figure 5) uses a power transformer (T6301) and two bridge-rectifier circuits to develop sources of unregulated 12-volts DC and unregulated 18-volts DC. A third unfiltered supply, using diodes D107 and D108, produces the "power-off detector" supply. This voltage is applied to the Regulator and Transport board logic system to sense a power failure and operate the **stop solenoid** so that the machine is not left in an operating mode in the event that AC power is lost. A second power transformer (T6302) furnishes 16-volts AC and 3-volts AC to operate the digital timer.

AC power for the main power transformer (T6301) and the timer power transformer (T6302) is supplied from the AC line through a 1.6A fuse (F101). Because of the low power demand of the clock/timer, a separate 100-mA fuse (F104) protects the timer power transformer. Other fuses used in the power supply include F102 (3A) which protects the rectifier/filter system producing unregulated 12-volts DC and fuse F103 (3A) which protects the unregulated 18-volt supply.

The illustration **"B+ Distribution — 1"** (Figure 6) shows that the **unregulated** 12-volt supply output is applied to the Regulator and Transport board whereupon it encounters some switching which will be described shortly. This voltage is also supplied to the D-D Motor board where it provides input power to operate the three-phase inverter that ultimately drives the D-D cylinder motor.

The unregulated 18-volt supply is also applied to the Regulator and Transport board whereupon it provides power to operate much of the logic circuitry contained on this board as well as the **stop solenoid.** Also derived from the unregulated 18-volt supply is regulated 12-volts DC which is generated by a series-regulator circuit that utilizes low-level driver circuitry on the Regulator and Transport board, and a power transistor (TR 6301) which is chassis mounted. The regulated 12-volt source appears at the emitter of transistor TR 6301 and is measurable at test point TP 614. It is also interesting to note that the "power-on" indicator (an LED) is powered from the regulated 12-volt source. Thus, from the servicing standpoint, if stop-solenoid action is heard when the in-

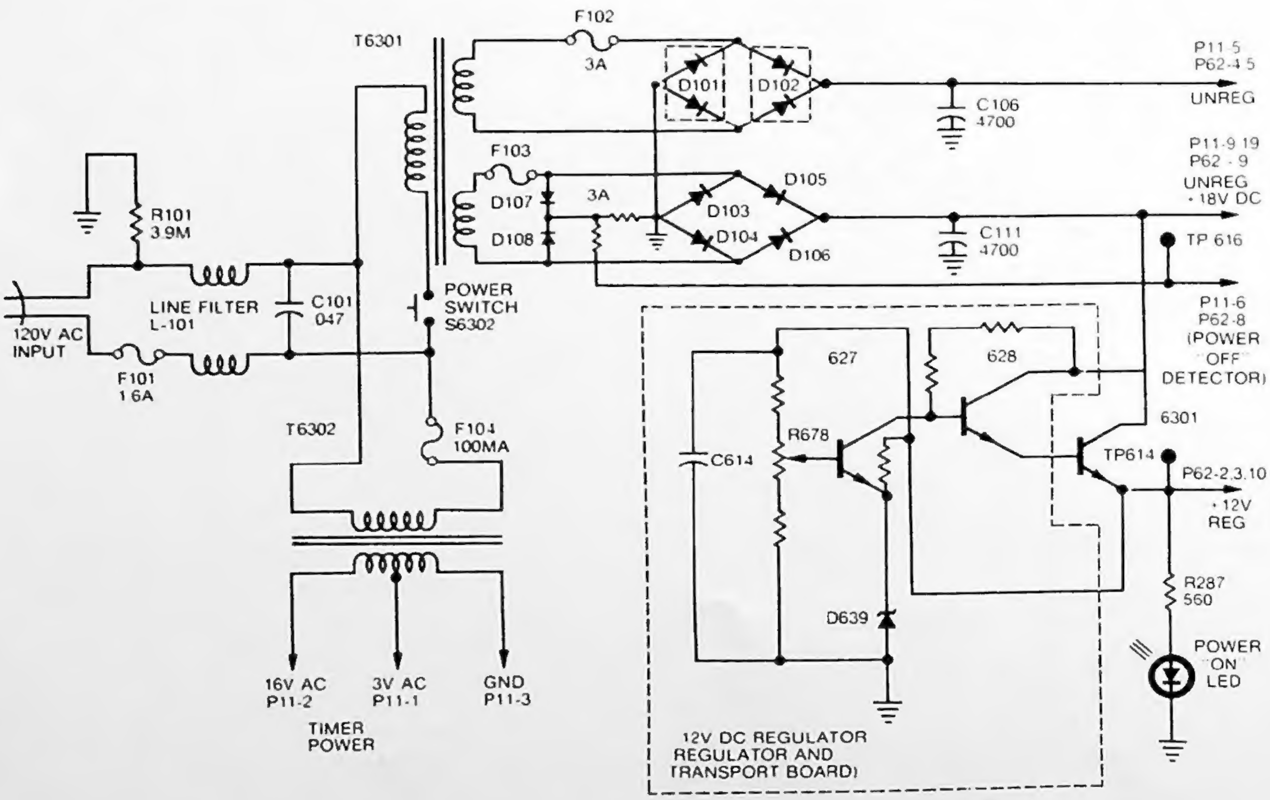


Figure 5. Power Supply and +12V DC Regulator

POWER SUPPLY CIRCUITS
(continued)

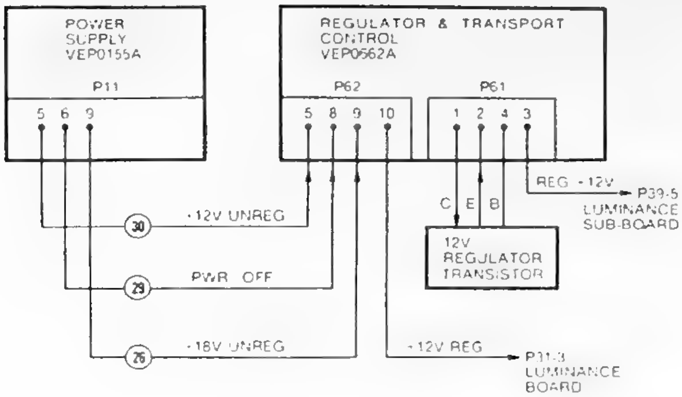


Figure 6. B+ Distribution—1

strument power is turned "on" and "off," but the "power-on" indicator does not come "on," it is indicative of a problem in the regulator circuit because the 18-volt supply powers the stop solenoid and furnishes input voltage to the regulator which ultimately drives the "power-on" LED. It will be found that the majority of the circuitry in the VBT200 instrument is powered from this **regulated** source of **12 volts**. However, as will be learned, the regulated 12-volt source is divided into several subsources through switching and various logic functions.

In summary, the power supply circuit provides three voltages to the Regulator and Transport board. These voltages are +12-volts unregulated, "power-off" indicator voltage, and +18-volts unregulated. These are all directed to the Regulator and Transport board. A driver circuit on this board supplies bias to the 12-volt regulator transistor (TR 6301) which is chassis mounted. Also associated with plug P61 pin 3 is the regulated output of 12 volts from this board which is applied to the Luminance Subprocess board via P39-5.

Referring to the block diagram "**B+ Distribution — 2**" (Figure 7) it can be seen that several additional 12-volt supplies are obtained from the Regulator and Transport board. These voltages, for the most part, are routed to the Servo board. Notable exceptions are that plug P63 supplies 18-volts unregulated to operate the **stop solenoid** as-well-as a source of regulated 12 volts for the Audio board in the machine.

Looking at the B+ sources that emerge from P65 (routed to the Servo board), it can be seen that there are several. Available at pin 1 of P65 is a source of 12 volts that is called "**+12V Loading End.**" This voltage becomes available at the completion of loading in the machine because switch S6305 closes at the completion of loading and provides this voltage to the Servo board. Pin 2 output is +12-volts regulated which supplies the majority of the circuitry in the VCR that is common to the Record and Playback modes. Pin 3 supplies +12-volts unregulated which primarily supplies power to the D-D cylinder motor three-phase inverter circuit. A source of voltage known as "**Forward +12 Volts**" is available at pin 6. This voltage becomes available when the FWD leaf switch on the Transport board is actuated by the **PLAY** button. This voltage ultimately is processed into several different sources of "Play" and "Record" voltages. Pin 4 supplies a voltage which is a "**Fast-Forward/Rewind +12-Volt override voltage**" that is sent to the SP/LP Auto Select board. The purpose of this voltage is to inhibit LP motor speed whenever the machine is in "Rewind" or "Fast Forward." Finally, emerging from plug P65 pin 8 is a voltage source known as "capstan-motor on." This voltage becomes available at the instant the **unload-finish** switch (S6304) opens, to signal the capstan motor that the machine has started to load; thus, the capstan motor drive circuitry is enabled so that the motor begins to run.

Transport and Control Switched B+ Circuits

As shown in Figure 8, regulated +12-volts is applied to three leaf switches on the board which are activated by the **PLAY, FAST-FORWARD,** and **REWIND** buttons. Switch S602, designated on the schematic as the FWD switch, is activated when the **PLAY** button is depressed. When the switch closes, the Forward +12-volt supply is made available to the servo section via P65-5. At the same time, closure of the FWD switch produces an input to the loading motor logic that signals the machine to start loading tape. Activation of the "Fast-Forward" or "Rewind" functions closes switches S601 or S603 respectively, and by so doing provides the source of FF/REW +12 volts to the SP/LP board via P65-4. This voltage forces the SP/LP select logic to operate the capstan motor in the SP mode to assure high-speed Rewind and Fast-Forward operation. Also, closure of either of these switches provides "capstan-motor on" logic voltage via P65-3 to the servo section which enables the capstan to operate during Fast Forward or Rewind.

All of these voltages, with the exception of the Fast Forward/Rewind +12 volts, are applied to the Servo board via plug P22. The Servo board, through switching and some delay and logic circuitry, provides several additional switched B+ supplies in addition to routing +12-volts unregulated to the D-D Motor board.

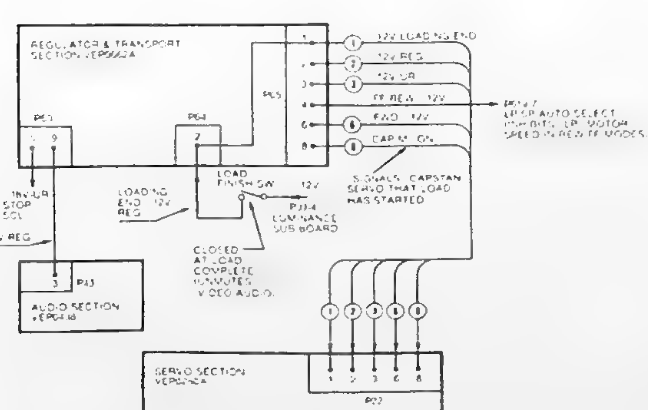


Figure 7. B+ Distribution—2

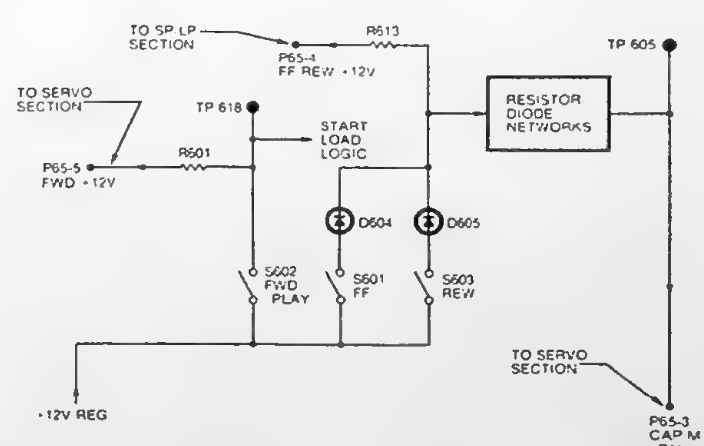


Figure 8. Transport & Control Switched B+ Circuits

POWER SUPPLY CIRCUITS
(continued)

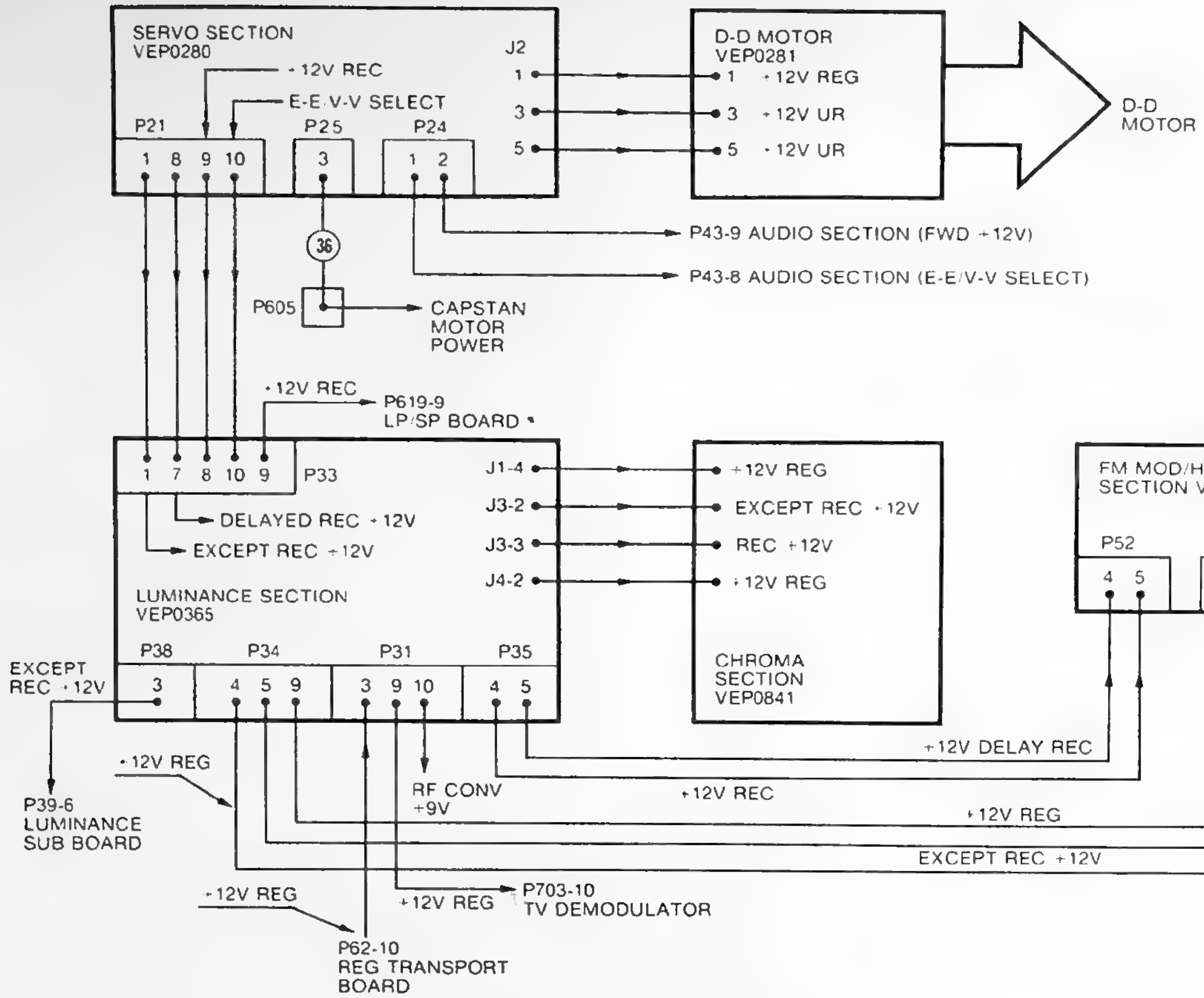


Figure 9. B+ Distribution—3

The illustration, **"B+ Distribution — 3"** (Figure 9) shows a source of voltage called **"Except Record +12 Volts"** is available at P21 pin 1. This voltage source is present in the "Play" or "E-E" modes of operation, but not present in "Record." Pin 8 of P21 supplies a voltage source called **"Delayed Record +12 Volts."** This voltage is supplied a brief instant after loading is completed as signaled by **load-finish** switch S6305. The source of this voltage is logic and time-delay circuitry located on the Servo board which is triggered by the closure of the load-finish switch. The "Record" selection function is obtained by passing this voltage through a section of the Record/Play switch so that the voltage is only present during "Record."

A similar voltage, **"Delayed-Forward +12 Volts"** (supplied to Audio board via P24 pin 2) is provided from the same time-delay circuitry. The only difference is that this voltage does not pass through the Record/Play switch. Consequently, the voltage is available any time the **PLAY** button is depressed — present in "Play" or "Record."

Also, a source of "Record" +12 volts is available from the regulated B+ source via a section of the Record/Play switch on the Servo board. This voltage emerges via pin 9 of P21.

Lastly, at pin 10 of P21 is a voltage known as the **"E-E/V-V Select Voltage."** This voltage is present when the machine is in the E-E mode of operation. Whenever Record or Play is initiated, this voltage source is defeated.

Other voltage sources emerging from the Servo board include the previously mentioned **"Delayed-Forward +12 Volts"** which is supplied to the audio section as well as **"E-E/V-V Select"** voltage which is also supplied to the audio section. Finally, emerging from plug P25 pin 3 is the DC voltage to operate the capstan motor.

The aforementioned "P21" voltages are supplied to the Luminance board via plug P33. As can be seen in the illustration, **"B+ Distribution — 3,"** (Figure 9) the Luminance board serves to distribute these various sources of B+ to other circuit boards in the unit. Power is applied to the Chroma board via the interconnecting wire jumpers that link the Chroma and Luminance board. Additionally, **"Except-Record +12 Volts"** is applied to the Luminance Subprocess board via P38 pin 3. Plug P34 supplies power to the FM modulator Head-Amplifier section of the machine. The same is also true of P35 pins 4 and 5. The Luminance board also supplies **+12-volts regulated** via P31 pin 9 to power the TV demodulator. Pin 10 of the same plug furnishes **+9 volts** for the RF Converter board.

POWER SUPPLY CIRCUITS
(continued)

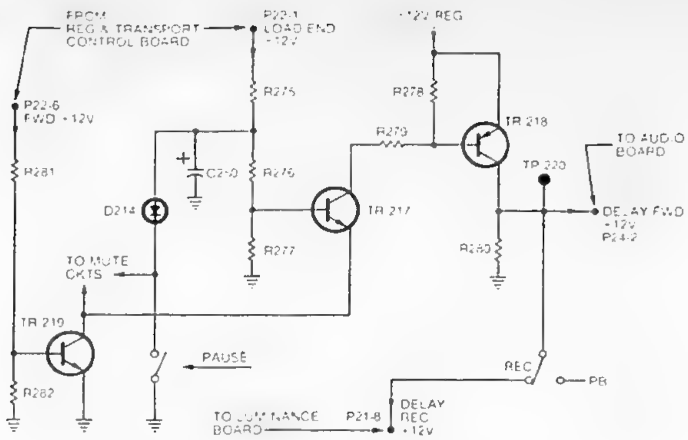


Figure 10. Servo Board Delayed B+

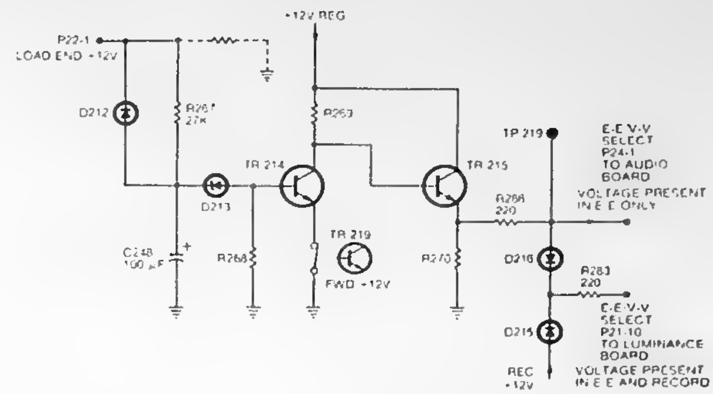


Figure 11. B+ Distribution E-E/V-V Select

Delayed B+ Source

As previously mentioned, the VCR uses two delayed voltages which are provided in order to allow the system to stabilize before Record or Playback is initiated after loading. The illustration, **"Servo Board — Delayed B+"** (Figure 10) shows the origin of these voltages. Basically, transistor TR 218 is an electronic switch which is gated by the combined action of TR 217 and TR 219. Whenever transistor TR 217 is conducting, as will be described, the collector of transistor TR 218 provides a source of **"Delayed-Forward +12 Volts"** to the Audio board via P24-2. This same voltage is fed to a section of the Record/Play switch on the Servo board so that the source of **"Delayed-Record +12 Volts"** is generated whenever the machine is in the "Record" mode. This voltage is applied to the Luminance board via P21-8.

Transistors TR 217 and TR 219 are connected in a logic configuration so that they can sense and "AND" together the **FWD (forward) +12 Volts** which is generated when the **PLAY** button is depressed together with the **Load-End +12 Volts** which becomes present at the completion of loading through closure of the load finish switch (S6305). Notice that base bias for transistor TR 217 is furnished via the load end +12 volts and R275. However, the transistor cannot conduct through the collector circuit of TR 219. Thus, TR 219 must also be conductive before transistor TR 217 can turn "on." Base bias to turn "on" transistor TR 219 is obtained from the **FWD +12 Volts** via R281. Thus, when FWD +12 volts is available and **Load End +12 Volts** is available, TR 217 turns "on" and thereby switches "on" transistor TR 218, making the aforementioned delayed B+ sources available.

Also associated with the delayed B+ source is an interface with the **PAUSE** switch (S604). As shown in Figure 10, the **PAUSE** switch, in addition to stopping the transport operation, also interfaces with the mute circuitry. But more relevant to this circuit area is some additional time delay provided by C250 in the base circuit of TR 217. Notice that when "Pause" is initiated (**PAUSE** switch closed), capacitor C250 is discharged through diode D214 and the base of transistor TR 217 is effectively grounded which removes the Delayed-Forward and Delayed-Record B+ sources. When the **PAUSE** switch is "open," a slight time delay provided by the RC constants of R275 and C250 delays the rise in B+ voltage at the collector of TR 218 long enough that the tape transportation again stabilizes before "Record" or "Playback" is permitted.

E-E/V-V Select

The illustration, **"B+ Distribution — E-E/V-V Select"** (Figure 11) shows an emitter-follower transistor (TR 215) that is powered from the +12-volt regulated supply to provide a switched source of bias to operate electronic switches on the Audio and Luminance boards that either select the E-E (monitor) mode of operation or allow the machine to function in Playback (V-V). When the instrument is in the monitor mode, transistor TR 215 is conducting and consequently supplies "E-E Select" bias to the Audio boards via plug P24 pin 1, and via diode D216 and P21-10, the voltage is supplied to the Luminance board. When the machine goes into the "Record" or "Playback" mode, the "E-E Select Voltage" is turned "off," allowing the machine to function in Play or Record. Notice that in the "Record" mode, diode D215 supplies **Record +12 Volts** to the same circuitry on the Luminance board which is active for "E-E" mode operation. This means that this particular circuitry must be deactivated when the machine is in the Playback mode. Base bias (control voltage) for transistor TR 215 is obtained from another device (transistor TR 214) which implements an "AND" logic function between the **Load End +12 Volts** and the **Forward +12 Volts.** Notice that base bias for this device is supplied via an RC time-delay network from the Load End +12-volt supply and that the emitter of the device is grounded via the collector/emitter circuit of TR 219 which conducts when **Forward +12 Volts** is available. Thus, in actual operation, depressing the **PLAY** or the **RECORD/PLAY** buttons immediately causes conduction of transistor TR 219 when **"Forward +12 Volts"** is applied from the leaf switch on the Regulator and Transport board. At the completion of loading, capacitor C248 charges through R267 until sufficient voltage is present on the capacitor, at which time zener diode D213 conducts and drives the base of transistor TR 214 into saturation, causing the collector of this device to go low, remove base bias from TR 215, and turn it "off."

The time-delay action provided by R267 and C248 delays the transition from "E-E" (monitor) mode into the "Record" or "Play" mode for a period long enough to allow tape transportation to stabilize.

RECORD/PLAY CIRCUIT OPERATION

This section explains the elements of operation of the Record and Play electronics of the VBT200 VHS 2/4 Hour Video Cassette Recorder. Through the use of block diagrams and other supportive illustrations, this section will acquaint the VCR service technician with the basic concept of the video signal processing system used in this instrument. Additional explanation and illustrations will familiarize the technician with the systems signal path and it's associated test points.

Comparison Between 2-Hour and 4-Hour Modes

The VHS standard for tape interchangeability is in the 2-hour mode of operation. (Most machines will allow interchange of 4-hour mode tapes.) When operating the VBT200 machine in the 2-hour mode, 38 micron wide video tracks are layed down with a 20 micron guardband between tracks. The VHS standard employs a mechanical design and tape speed which allows alignment of horizontal sync pulses in adjacent video tracks on the tape. Horizontal sync pulse alignment is desirable because it minimizes the effect of any slight mistracking due to the fact that adjacent fields of a picture (tracks) have similar signal content.

Standard in the VHS format is a technique known as "6-dB burst-up." Basically, increasing the amplitude of color burst when it is recorded minimizes chroma phase distortion during playback that could result from attenuation of burst.

A technique known as color subcarrier rotation is used in the VHS standard to allow a means of processing the color signal to eliminate crosstalk components that are introduced due to slight mistracking. This circuitry is extremely sophisticated and complex, so at this point it will suffice to say that it is a desirable feature that significantly enhances the color picture quality.

As will be seen, a special FM interleave technique is used in the 4-hour mode to eliminate a beat pattern that could be produced by interaction of nonsimilar crosstalk with the RF head signal. This circuitry is nonoperative when the machine is used in the 2-hour mode in order to make it compatible with the basic VHS tape standards.

Enhanced video signal-to-noise ratio is achieved if the high frequencies of the video signal are boosted during "Record" and then rolled off during playback; thus, a nonlinear video emphasis network boosts high frequency video approximately 2 to 3 dB in the 2-hour mode.

When operating in the 4-hour mode, linear tape speed is cut in half. Because of this, the guardband between adjacent tracks disappears — in fact, a portion of the previously recorded track is erased each time the video head lays down a new one. Consequently, the video track width is reduced to 29 microns (approximately 30% reduction). Because of this, the video head RF signal is lower in the 4-hour mode. This means that there is a slight degradation in signal-to-noise performance which is virtually unnoticeable on a normal TV set.

Because the linear tape speed has been reduced, the physical parameters of the machine no longer allow horizontal sync pulse alignment when the machine is operating in the 4-hour mode. Under this condition, it is possible for a crosstalk component to contain the 3.4-MHz black sync tip information and beat with the predominantly white area of the picture producing a beat component that approaches 1-MHz in frequency. Due to the azimuth recording technique which reduces luminance crosstalk by about 18 dB and the FM interleaving technique used in 4-hour operation, the effect of this beat is made unnoticeable on the TV screen.

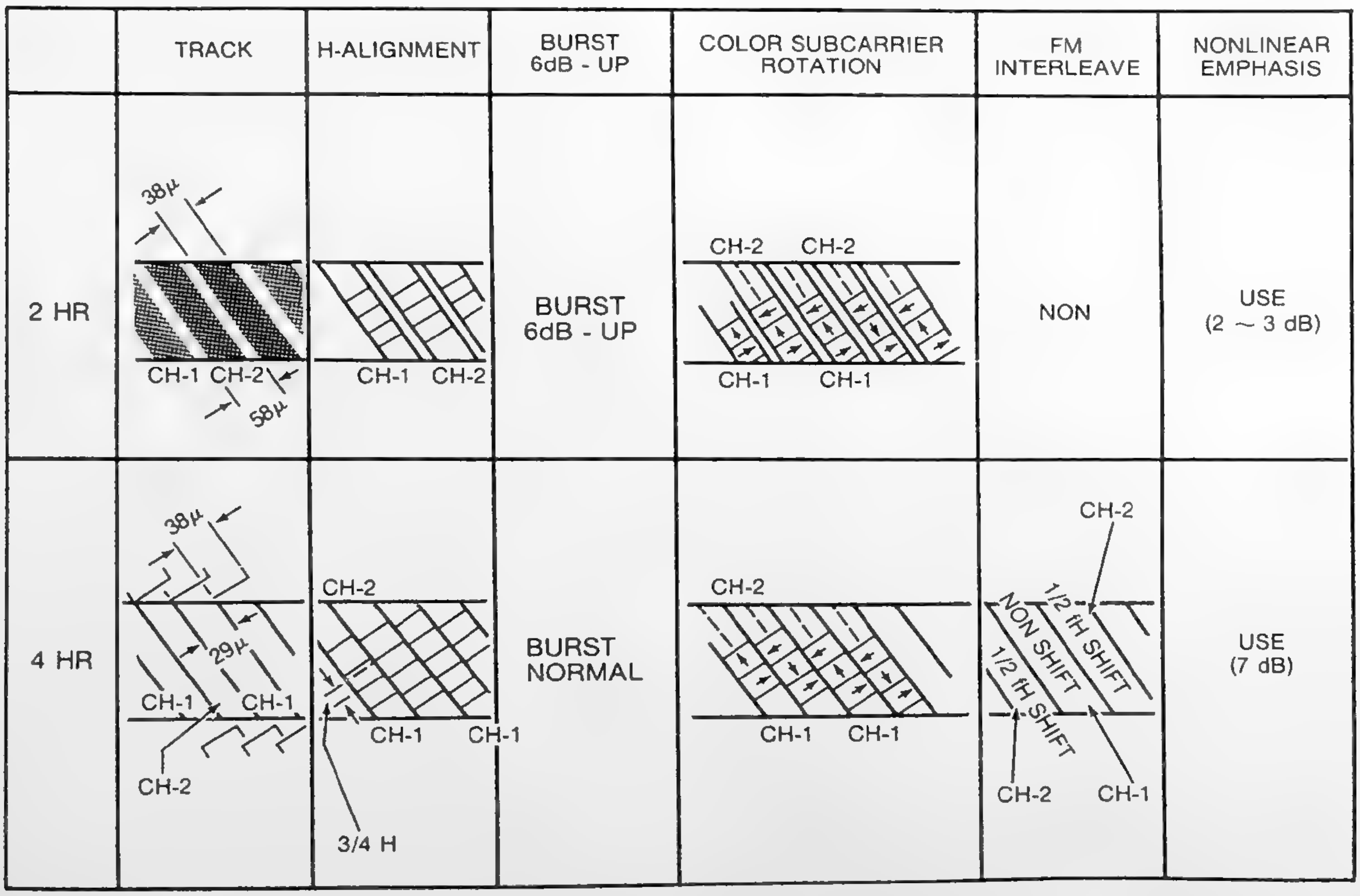


Figure 12. Comparison Between 2-Hour and 4-Hour Operation

RECORD/PLAY CIRCUIT OPERATION (continued)

To prevent the possibility of beats in the color due to "non-H alignment," 6-dB burst boost is not used in the 4-hour mode. However, careful consideration has been given to circuit design in this machine to allow normal operation without the burst-boost circuitry — the color subcarrier rotation technique is also used in the 4-hour mode.

Frequency interleave circuitry is used for 4-hour operation to cancel the beat that is introduced due to crosstalk pickup of a frequency differing from the main signal luminance frequency. Basically, the channel-1 head records video frequencies at signals ranging from 3.4 MHz plus ½ frequency H (7875 Hz) to peak white 4.4 MHz plus 7875 Hz. The channel-2 head records basically 3.4 to 4.4 MHz. By introducing this half a horizontal line frequency offset in the FM modulator frequencies, it is possible to create a condition where the beat pattern on adjacent lines are out of phase so that there is optical cancellation of this slight beat at normal viewing distances. Because video track width is reduced and head output is lower, additional nonlinear emphasis (7 dB) is used to improve the signal-to-noise performance of the machine in the 4-hour mode.

A user switch selects 2-hour or 4-hour operation during "record." When the tape is played back, special logic circuits sense the control track frequency and switch the operating speed accordingly. The actual circuits involved in the 2-hour, 4-hour switching will be more apparent as the reader studies the following text and block diagrams.

Signal Circuit — "Record"

As shown in the simplified Signal Circuit Block Diagram (Figure 13), during video recording, video signal (1-volt negative sync) from either the internal TV demodulator package or an accessory camera is applied to the input of the machine where it follows separate luminance and chrominance paths. The luminance, or black and white video portion of the signal, enters an AGC amplifier where its level is regulated to remove any variations due to differences between signal input. This regulated signal then passes through electronic-switch selectable 2-hour or 4-hour emphasis circuits which boost the high frequency component of the video signal. The signal emerging from the emphasis network contains overshoots which are clamped to specified levels by black-level and white-level clamps.

The output of the clamping circuits is thus video signal with specified overshoots. This signal is applied to the FM modulator which is basically nothing more than a flipflop that operates at 3.4 MHz when an input voltage corresponding to sync tip level is present. As the video signal drives the modulator, its frequency approaches 4.4 MHz. FM modulator output is applied to a record amplifier which boosts the signal level to that required to drive two video heads which are connected in parallel during "Record."

In the 4-hour operating mode, a 30-Hz squarewave signal is supplied to the FM modulator to shift the DC level of the video signal up on alternate fields. This action raises the modulating frequen-

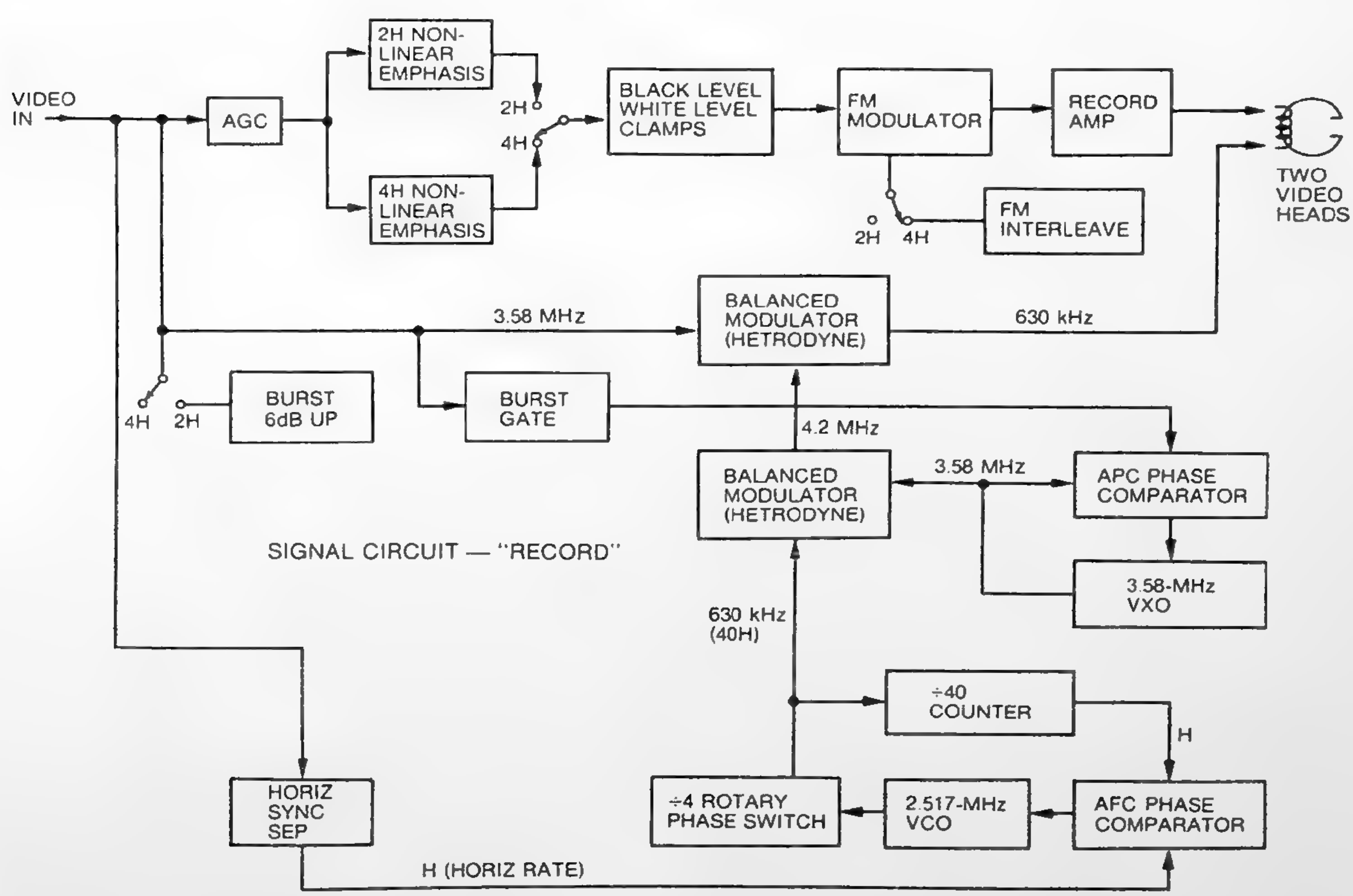


Figure 13. Signal Circuit "Record"

RECORD/PLAY CIRCUIT OPERATION (continued)

cies by the 1/2-frequency H (7875 Hz) interval necessary to minimize luminance beats caused by nonhorizontal sync pulse alignment.

The chroma signal, after passing through some bandpass filtering to remove the luminance component, is applied to a balanced modulator where it is hetrodyned against a 4.2-MHz signal. The difference between these two signals is 629 kHz which thus becomes down-converted chroma. This signal is mixed with the high level luminance signal so that the luminance FM is used as bias to record chroma — much like an audio tape recorder. During "Record," burst is separated from the incoming chroma and applied to an APC comparator much like that of a TV set. This action phase-locks a 3.58-MHz VXO (Variable Crystal Oscillator) so that it produces a 3.58-MHz CW signal which is applied as an input to a second balanced modulator. The other input to this balanced modulator is 629-kHz CW manufactured by a special VCO (Voltage Controlled Oscillator) oscillator and counter circuit. Balanced modulator output is the sum of the 3.58-MHz input and the 629-kHz input which is roughly 4.2 MHz needed to drive the second balanced modulator that down-converts chroma.

During "Record," the video signal is applied to a horizontal sync separator to provide horizontal sync that phase locks a 2.517-MHz VCO (Voltage Controlled Oscillator) to a multiple of 160 times the horizontal line frequency. Output from the 2.517 VCO is divided by 4 in the rotary phase switch (÷ 4 counter). Counter output is 629-kHz CW that phase changes line by line as the video is recorded or played back. One of the 629-kHz signals is divided by 40 and is compared against horizontal sync in a TV-type AFC. The control voltage output from the AFC circuit, circuit locks the 629-kHz CW signal to horizontal sync.

Signal Circuit — "Play"

In playback, the two video heads feed individual preamps which are turned "on" when the particular head is in contact with the video tape. Preamplifier output is summed together into a continuous RF signal prior to entering separate luminance and chroma circuits.

The luminance (black and white signal) is 3.4- to 4.4-MHz FM which is applied to limiter stages that remove all amplitude variations including the chroma signal content. Limiter output drives an FM demodulator which recovers the original black and white video signal complete with the overshoots introduced by the record emphasis. In order to correct frequency response of the video signal (and attenuate high-frequency noise), the signal is passed through appropriate de-emphasis networks which are switchable for 2-hour or 4-hour operation. After de-emphasis, the video signal passes through some noise cancellation circuitry and emerges as 1-volt p-p negative sync video to drive the RF converter in the instrument to provide channel -3 or channel -4 output to a television set.

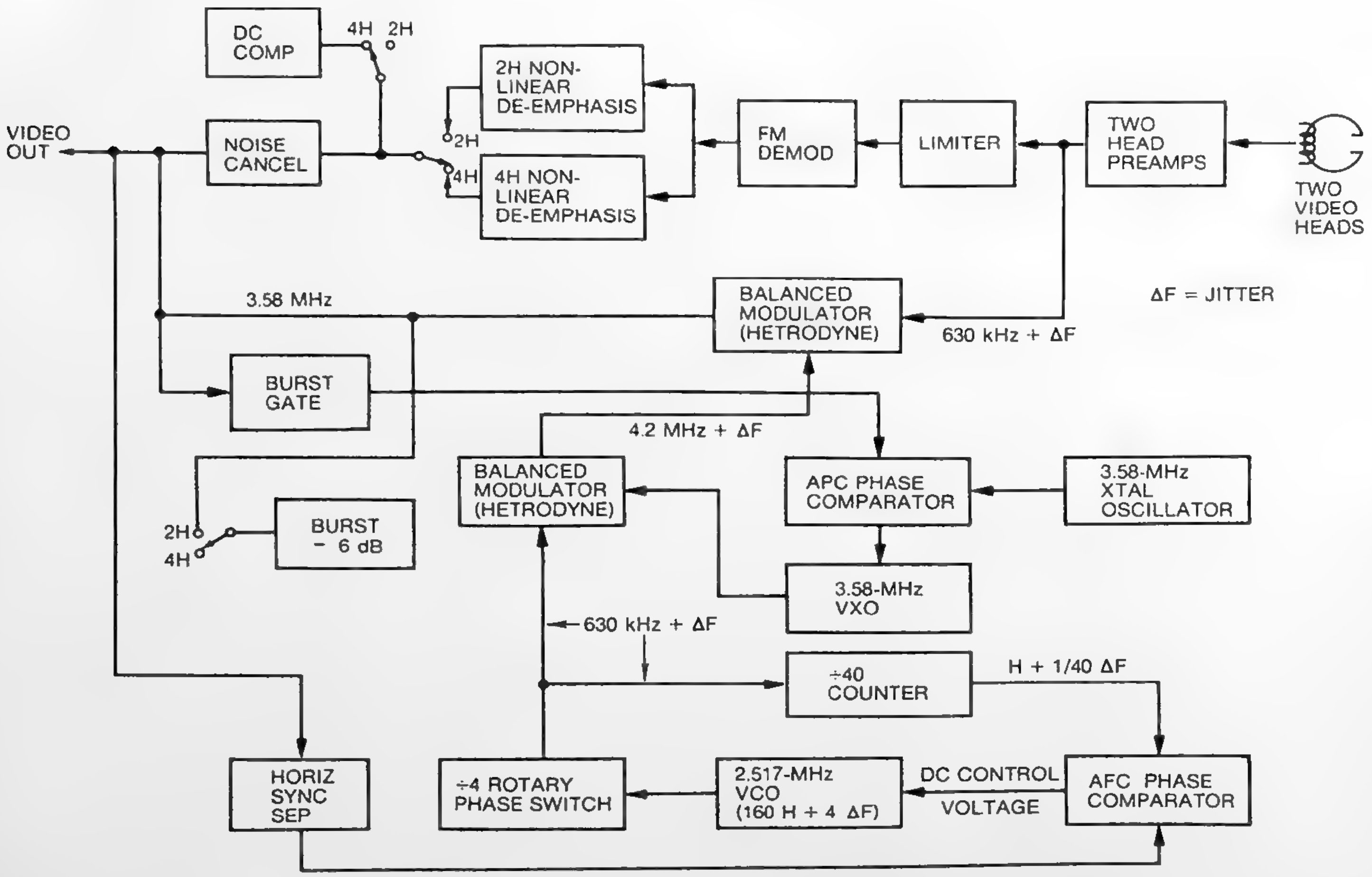


Figure 14. Signal Circuit "Play"

RECORD/PLAY CIRCUIT OPERATION (continued)

A DC compensation stage is switched-in when in the 4-hour operating mode to remove the DC level shifts that were introduced in "Record" to produce the half line offset. This DC compensation is a 30-Hz squarewave which corrects the DC component of the video signal in the shifted fields to agree with the DC level of the video in the nonshifted fields.

The chroma signal consists of 629-kHz RF plus a **jitter-frequency** component. The term "jitter frequency" is easily explained: Ideally, the video-head speed and the tape-transportation speed are held to very tight tolerances, and in practice they are. However, an extremely small change in video-head velocity, which would produce no noticeable change in a black and white picture, can produce chroma phase errors so severe as to make the picture unwatchable. Thus, somehow this effect of minute speed variations which are called the jitter component or ΔF must be removed in order to display proper color. Some thought will reveal if the 629-kHz down-converted chroma signal containing jitter is beat against a 4.2-MHz signal that contains the same jitter component; the difference will be a constant 3.58-MHz signal without the jitter component. This is accomplished by passing the 629-kHz signal into a balanced modulator where it is beat against 4.2-MHz with jitter, thereby producing a constant output of 3.58-MHz chroma. In playback, this 4.2-MHz signal plus jitter is produced by the second balanced modulator.

During playback, the 3.58-MHz VXO is locked to a locally generated constant 3.58-MHz signal derived from a crystal oscillator. The other input to the balanced modulator is 629-kHz plus the jitter factor. The 629-kHz signal is provided by the same 2.517-MHz VCO used in "Record." Recall that the VCO locks to horizontal sync. Because in playback, the horizontal sync pulse contains the small time-base errors caused by minute variations in headwheel speed, the playback horizontal sync pulse can be applied to the AFC phase comparator to produce DC control voltage with jitter modulation. Consequently, this jitter is introduced into the 2.517-MHz signal whose output is divided to 629 kHz. In this way, the 629-kHz output contains the jitter component and thus cancels the jitter in the 629-kHz incoming chroma.

RECORD/PLAY CIRCUIT DETAILS

After studying the text and examining the simplified "Record" and "Play" block diagrams (Figures 13 & 14), the reader should have a basic understanding of the video "Record" and "Play" circuitry used in the VBT200. In the text that follows, additional block diagrams will explain the circuitry in more detail. As will be learned, three distinct modes of operation of the video circuitry are evident. These include the monitor or "E-E" mode as-well-as "Record" and "Play." Each of these operational modes will be explained separately with the aid of block diagrams.

"E-E" Operation

Prior to the start of recording, the VBT200 is in a mode of operation known as "E-E" which couples the input signal from the TV-demodulator package, or an external camera, through some of the "Record/Play" electronics and then to the video-output circuitry where it modulates the RF converter for ultimate transmission to a television receiver. The purpose of "E-E" operation is to allow the user to view the picture he is preparing to record. For example, it allows the user to determine that the camera is properly focused, or that the TV demodulator of the VBT200 is tuned to the proper channel.

As shown in Figure 15, video signal from the TV camera selector switch is routed to the Luminance Circuit board via P32-1. This 1V p-p negative-sync signal is viewable at test point TP 301 which is

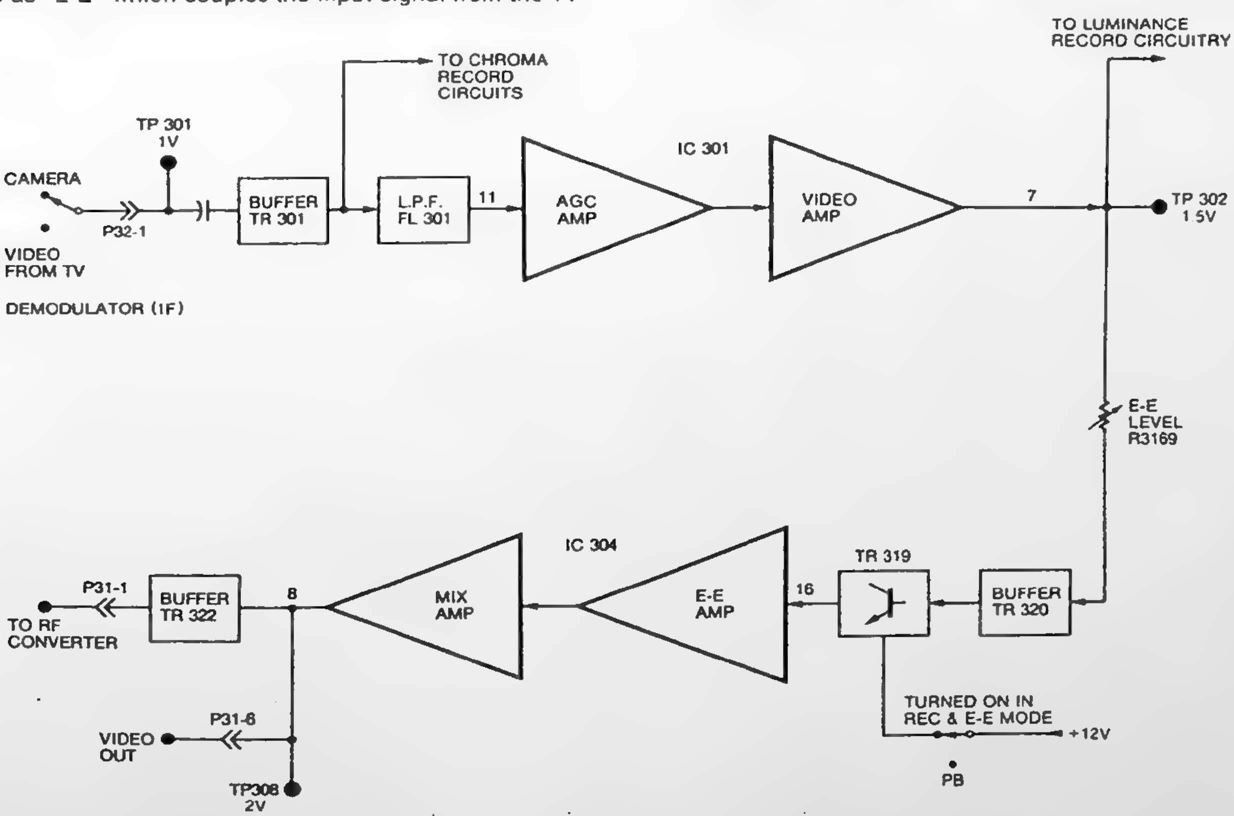


Figure 15. Simplified E-E Block Diagram

RECORD/PLAY CIRCUIT OPERATION (continued)

the input to a buffer amplifier (TR 301) that serves as an isolation and gain stage to prevent the following circuitry from loading the VCR video input.

The buffered video signal is applied to a low-pass filter comprised of packaged LC components designated as FL 301 — filter cut-off frequency is approximately 5.8 MHz. The purpose of the filter is to remove any high-frequency components from the input composite-video signal. Output signal from the filter passes into phase-compensator transformer T301 whose purpose is to correct the phase shifts introduced by the low-pass filter. Phase-compensated video signal is then applied to pin 11 of video-processing chip IC 301.

Blocks within IC 301 indicate that the composite-video signal (including color) are fed to an AGC amplifier whose purpose is to correct any abnormal input level conditions and thus provide a reasonably constant 1-volt video signal to the actual video-record circuitry. AGC regulated video is then coupled to a video amplifier which is part of the same chip. Video-amplifier output emerges from IC 301 at pin 7. This video signal is applied to a video buffer stage consisting of transistor TR 320 via **"E-E" level** control R3169. Buffer output is routed to a second signal-processing IC (IC 304) via electronic-switch transistor TR 319 — transistor is turned "on" during "Record" and "E-E" operation. Switch output (video) is applied to IC 304 through pin 16 of the device.

Video-processing IC 304 is primarily part of the playback circuitry. As shown in the block diagram (Figure 15), composite video (including color) is applied to an "E-E" amplifier stage. Output of this stage is fed into a mixing amplifier whose output emerges from the chip at pin 8. At this point, the video signal is 2V p-p as can be determined at video-output test point TP 308. This output signal is taken off the Luminance board via P31-6 where it is padded down to a 1V p-p signal for the video output jack on the rear of the instrument. Signal from pin 8 is also directed through video-phase-compensator transformer T307. A buffer stage following the phase compensator makes video signal available to the RF converter via plug P31-1.

Luminance Record Circuits

In many respects, the input to the luminance record system closely resembles that of the "E-E" circuitry because the same electronics are used as shown in Figure 16. Briefly, video signal from the input is applied to the previously described buffer and filter circuitry via P32 pin 1 and TP 301. Video signal entering IC 301 pin 11 is applied to the same AGC and video amplifier stages — output is pin 7 of the IC or TP 301. From this point, the signal takes a different path than it did in the "E-E" mode.

Pin 7 video at an amplitude of approximately 1.5V p-p (as viewed at TP 302) passes through a 3.58-MHz trap which removes the chroma signal components. This trap is switched "in" and "out" of the circuitry by the color-killer system. Basically, when the instrument is in the "color" mode, additional low-pass filtering is introduced in the video circuitry to prevent chroma/luminance beats.

Luminance video signal is then routed to switchable 2-hour/4-hour nonlinear video emphasis circuitry contained on the FM Modulator Record and Head Amp board via P37-5. Nonlinear emphasized video is returned to the Luminance board via P37-1 where it is applied back into IC 301 via the **FM-deviation** control (R3161) whose purpose is to regulate the peak-to-peak video level so that the proper signal amplitude is ultimately applied to the FM-modulator circuitry on the FM-Modulator board.

The video signal, once again being processed by IC 301, enters the chip at pin 3 where it encounters additional amplification and pre-emphasis — high frequency boost. Output from the pre-emphasis circuitry leaves the chip at pin 1 and re-enters the chip at pin 15 where it encounters a sync-tip clamper circuit that provides DC restoration of the video signal.

Clamped video (TP 303) is a signal of somewhat over 1V p-p that contains sizable overshoots (spikes). The purpose of pre-emphasizing (overshoots) the signal is to improve the high frequency signal-to-noise performance of the instrument as well as providing enhancement of picture definition. However, it is impor-

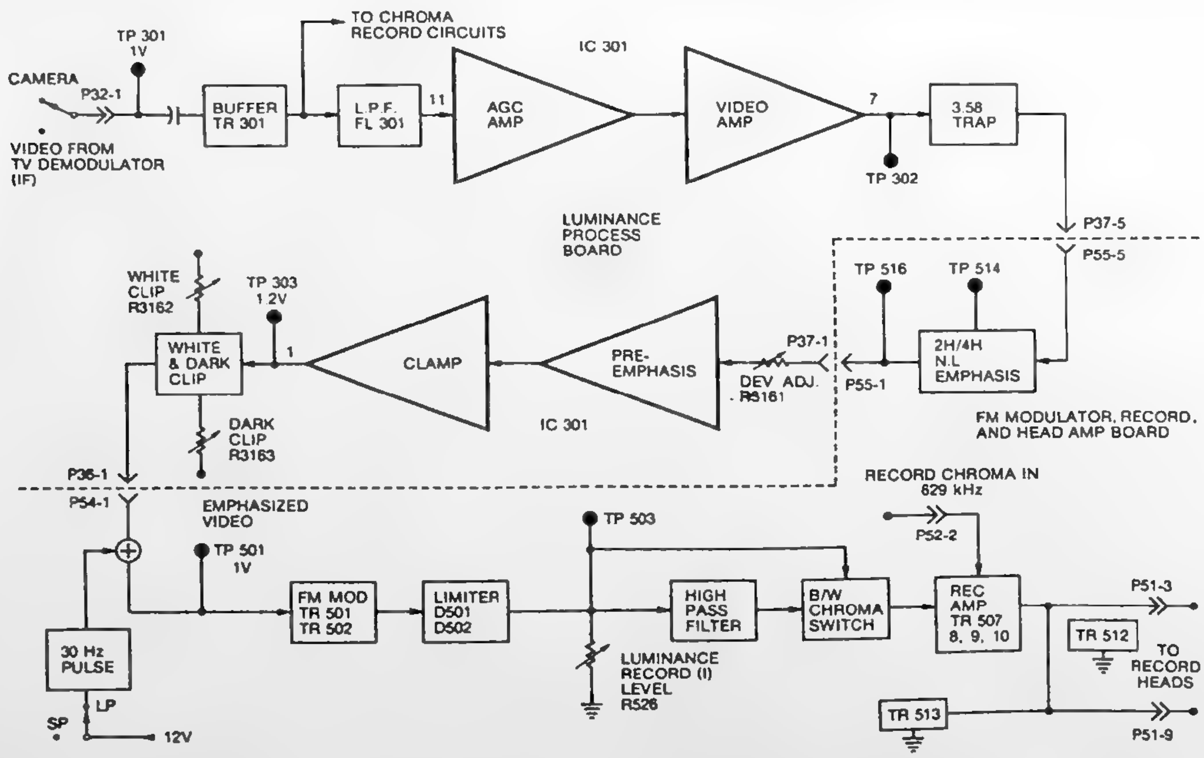


Figure 16. Simplified Luminance Record Block Diagram

RECORD/PLAY CIRCUIT OPERATION (continued)

tant that the overshoots be limited to proper levels to prevent overdeviation of the FM modulator. Consequently, separate white-clip and dark-clip stages (transistors TR 304 and TR 305) are provided. Associated with these two stages are individual controls, R3162 **(white clipper)** and R3163 **(dark clipper)** which are used to set the clipping level and thereby regulate the amount of overshoot Pre-emphasized and clipped video output is applied to the FM-Modulator Record and Head Amp board via P36-1.

Input to the FM modulator is emphasized clipped video from the Luminance board which enters via P54-1. After passing through an adder stage (shown as circle with + inside) the video signal is applied to the FM-modulator circuit. When the unit is in the 4-hour operating mode, a 30-Hz squarewave signal is added to the video to produce the alternate field level shifting necessary for generating the ½-frequency H offset from field-to-field. The FM modulator is simply a multivibrator (flipflop) — transistors TR 501 and 502. When the input voltage corresponds to sync-tip level, the FM modulator runs at 3.4 MHz. When video is applied, and the signal is driven towards white, the multivibrator frequency is driven upwards in response to the video signal. The FM modulator output is transformer coupled to a pair of limiter diodes which remove any amplitude variations from the FM signal. Limiter output can be viewed as an FM signal of approximately .6V p-p at test point TP 503. This signal, after being level regulated by **luminance record level** control R526, is applied to an amplifier stage consisting of TR 503 which drives emitter-follower TR 504.

Output from the emitter follower is routed through a high-pass filter which is selected by "color-mode" switch TR 506 when the unit is operating with a color input signal. When the unit is operating in the black-and-white mode, switch TR 505 routes signal directly to the video-record amplifier. The purpose of the high-pass filter used in color "record" is to prevent FM-modulation components from interacting with the 629-kHz chroma signal and producing beats. Consequently, this filter has a cut-off frequency of approximately 900 kHz. The video-record amplifier (transistors TR 507, 508, 509, and 510) boosts the level of the luminance record signal to provide approximately 12 mA of luminance-video record current at the input to the D-D assembly.

Observe that the 629-kHz down-converted chroma enters the record amplifier via P52-2 where it is mixed with the luminance component. Thus, the output of the record amplifier is luminance FM with about a 3-mA chroma record current mixed. This signal then is routed to the individual video heads which are driven in parallel.

Notice in Figure 16, that "Play/Record" head switching is accomplished electronically. When the unit is in "Record," the record signal is applied to the heads (via individual transformers) through P51-3 and -9. The ground ends of the video heads are returned to the circuit board via P51-1 and -10. Notice that the heads are grounded through switching transistors TR 514 and TR 515 which are "on" when the unit is in "Record." Notice too, that these switches also ground the input of the playback preamplifiers and peaking capacitors C530 and C545 to prevent them from interacting with the record current. Also evident is the fact that playback switches TR 512 and TR 513 are "off" when the unit is operating in the "Record" mode.

Chroma Record Circuits

The chroma "record" circuits are largely separate from the luminance processing as can be seen in Figure 17. Video signal again enters the Luminance board via P31-1 where it can be observed as a 1-volt signal at TP 301. This signal passes through isolating buffer TR 301 and is routed to the luminance and chrominance processing circuitry as shown. Notice in the block diagram that the video signal output of buffer TR 301 is applied to 3.58-MHz bandpass filter T308 which separates the chroma component from the luminance signal. The chroma signal then is applied to a stage designated as a "burst amplifier" which also serves as a chroma amplifier. The designation burst amplifier results from the fact that when the unit is operating in the 2-hour "Record mode," the burst receives an additional 6 dB of amplification to accomplish the desired 6-dB burst enhancement function which is part of the VHS standard In the 4-hour mode of operation, the additional burst boost is not used, and transistor TR 324 merely serves as a chroma amplifier stage. Output from the burst amplifier is viewable at test point TP 309. This signal is then

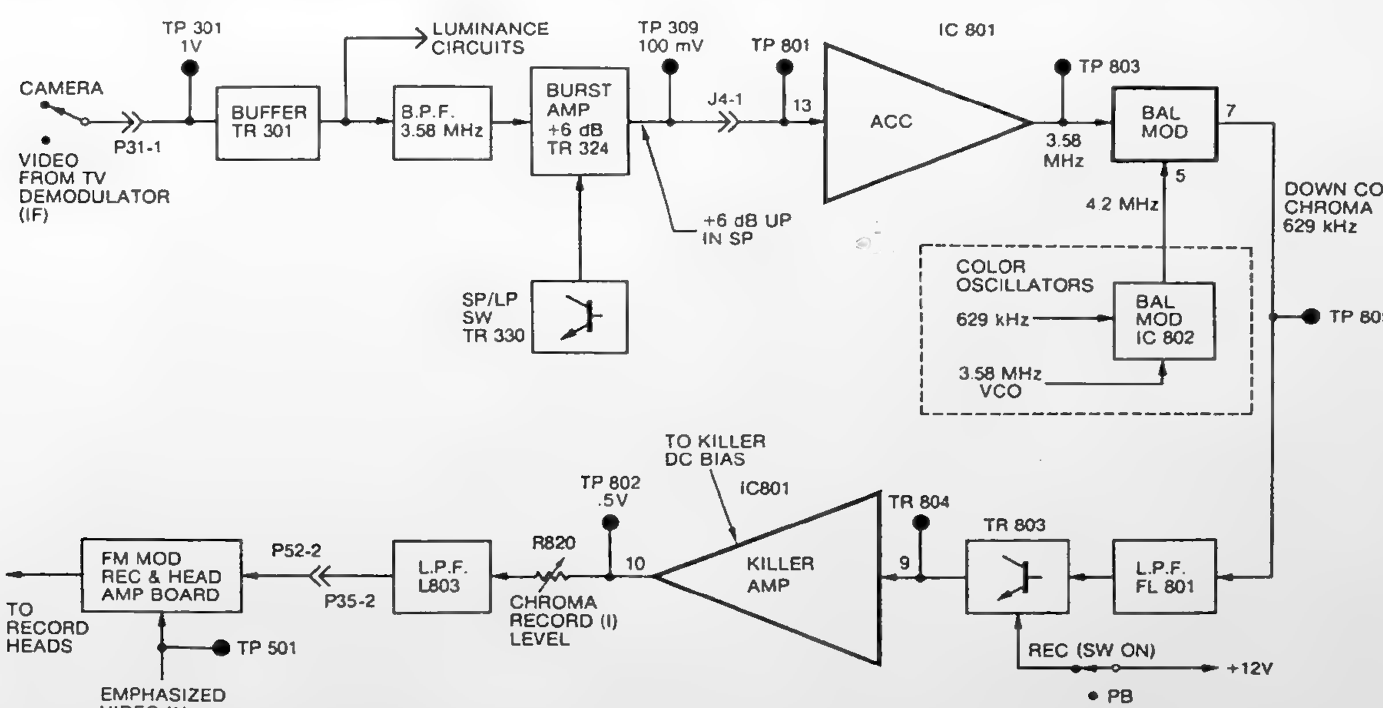


Figure 17. Simplified Chroma Record Block Diagram

RECORD/PLAY CIRCUIT OPERATION (continued)

routed to the Chroma board via interconnecting jumper wires that are contained in the package designated J4.

Once the signal is on the Chroma board, it enters chroma processing IC 801 at pin 13 — signal is viewable at TP 801. Once inside the IC, the chroma signal passes through ACC (Automatic Chroma Control) circuitry which removes any level variations, in the same way as ACC circuitry does in a color television receiver. ACC-regulated chroma is applied to a balanced modulator which is part of the same IC. The balanced modulator input is pin 3 of the IC and the signal is viewable at test point TP 803. Also entering the balanced modulator via pin 5 is a 4.2-MHz CW signal generated by beating 3.58-MHz VXO output CW with 629-kHz rotary phase CW in a second balanced modulator. The 629-kHz down-converted chroma signal (viewable at test point TP 805) emerges from the chip at pin 7.

A low-pass filter (C818 and FL 801) rejects everything except the 629-kHz chroma signal. Output from this filter (selectable by an electronic switch consisting of TR 803 which is "on" during "Record") is routed back to IC 801 via pin 9 — viewable at TP 804. Signal entering the chip passes through a killer-amplifier stage which is turned "on" and "off" by the color-killer circuit. When the unit is recording a color program, the killer-amplifier stage is active and passes signal via pin 10. This down-converted 629-kHz signal output is viewable at TP 802. After passing through the **chroma-record level** control (R820) and a low-pass filter (L803 and C807), the down-converted 629-kHz chroma is routed back to the Luminance board so it can be transferred to the FM-Modulator Record and Head Amp board via plug P35-2. Once on the FM-Modulator board, the chroma signal is mixed with luminance in the record-amplifier stages as previously described.

Luminance Playback Circuits

When video is recorded, one first thinks that the only frequencies recorded on the tape are those between 3.4 and 4.4 MHz which represent the black level and white level of the video signal respectively. In reality, as with any FM signal, sidebands are produced which consist of the sum and the difference between the incoming video signal frequencies and the instantaneous modulator frequency which corresponds to the scene brightness. Thus, a spectrum of signal is recorded on the tape that occupies approximately a 6-MHz bandwidth. As shown in Figure 18, the luminance frequency spectrum extends from approximately 900 kHz to a maximum of 6.9 MHz. This is easily calculated if the technician thinks of a condition where the instantaneous video frequency is 2.5 MHz and a black-to-white transition is made. Under these conditions, there will be signal components (sum of 4.4 MHz and 2.5 MHz) which extend out to 6.9 MHz. Obviously, lower sidebands of this same signal are produced that range down towards approximately 1.9 MHz. Similar calculations using a white-to-black transition and a maximum-frequency video signal would indicate that the lower limits of the spectrum are approximately 900 kHz. The sharp cut-off shown in the illustration at 900 kHz is due to the high-pass filter which is switched into the circuit during "Record" to prevent the luminance sideband components from interfering with the down-converted chroma signal. Thus, a filter minimizes beats between the luminance and chrominance signals. The color signal, which was mixed with the luminance signal in "Record," is a band of frequencies 1 MHz wide ranging from 129 kHz to 1.129 MHz, with the burst frequency being centered at 629 kHz. Thus, this is the composition of the signal as was recorded on the VHS format magnetic tape.

In playback, the video heads must recover the information impressed upon the tape and present it to the luminance and chroma systems to replicate the original video signal. Due to various electrical and physical phenomenon, it is necessary to shape the response of the "record" amplifier, and to compensate for the response of the "record" amplifier **and** the inherent limitations of the video tape when the signal is played back. Thus, preamplifiers with special response characteristics are used to restore proper frequency relationship to all of the sideband components when the signal is played back. Furthermore, due to slight manufacturing tolerances between the video heads, not only is it necessary to compensate for the overall video signal, but it is also necessary to match, or equalize, the individual heads so that the field-to-field variation of video signal (RF head signal) is minimal. Referring to Figure 19, casual observation shows that the two video heads drive individual integrated-circuit preamplifiers consisting of IC 501 and IC 502. During playback, one side of each head is grounded through electronic switches consisting of transistors TR 512 and TR 513 which are turned "on." The head signals are applied to terminal 2 of IC 501 and IC 502 respectively.

Associated with the input to these IC's are two trimmer capacitors known as "**peak-A**" (C530) and "**peak-B**" (C545) that set the resonance of the video heads for a peak response at 4.5 MHz. This response peak, and the frequency-response adjustments of the individual preamplifiers, create playback preamplifier frequency characteristics that properly restore the sideband levels to their proper frequency relationships.

Associated with each of the integrated circuit preamplifiers is a feedback frequency-response control network consisting of RC components and adjustable resistors R553 **("Q"-A)** and R565 **("Q"-B)** which are adjusted for proper playback frequency response characteristics. The outputs of both preamplifiers are fed to additional individual stages of amplification consisting of TR 501 and TR 518 and then to a summing point consisting of **mix control** R575.

As previously learned, it is desirable in video playback to turn "on" only the amplifier that is in contact with the video tape in

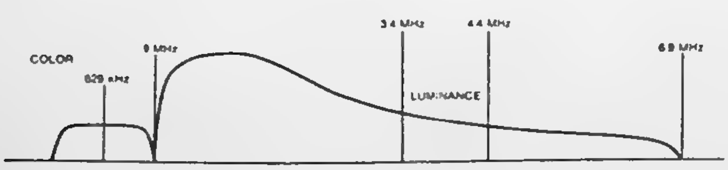


Figure 18. Record Frequency Response

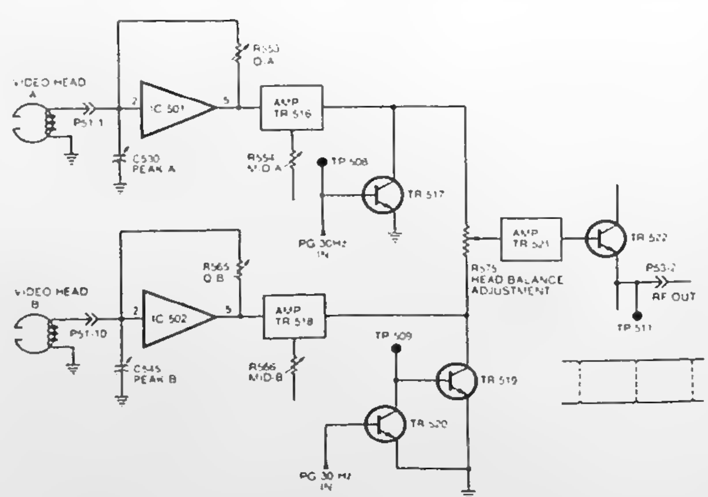


Figure 19. Head Amp Block Diagram

RECORD/PLAY CIRCUIT OPERATION (continued)

order to prevent the inactive video head from contributing noise to the input signal — the signal levels at the video heads are incredibly small and any stray noise, after amplification, will degrade performance. Consequently, switch transistors TR 517 and TR 519 are gated "on" and "off" to allow video signal to pass whenever the appropriate head is on the tape. The "summed" output of the heads receives additional amplification by transistors TR 521 and emitter-follower stage TR 522. The summed RF head signal (luminance FM and chroma) is routed off the FM Modulator Record and Head Amp board to the luminance and chrominance circuitry via P53-2. This signal is available for observation at TP 511. As shown in Figure 20, the RF head signal is applied the Luminance Processor board at P34-2 for input to the luminance and chroma processing circuitry.

After the RF signal passes through phase compensation filter FL 303, it is applied to the input of an amplifier contained in IC 302 — input signal viewable at TP 304. Output from the amplifier follows one of two paths: In the "color" mode, the signal is passed out of pin 3 of the IC through high-pass filter FL 302 and back into the chip via pin 5. The purpose of this filter is to reject the 629-kHz down-converted chroma. In black and white mode, an electronic switch in the chip routes the signal directly to the mixing amplifier, rather than passing it through the filter.

The mixing amplifier, in conjunction with some level detection circuitry and a 1-H (63.5 μs) delay line comprise what is known as the "dropout compensator." The dropout compensator is a desirable feature in a video tape recorder because its action masks the effect of defects in the tape which otherwise would cause flashes and streaks in the picture. Basically, the circuit operation of the dropout compensator is simple. When conditions are normal, RF-signal (luminance video before demodulation) is fed directly through into the limiter and demodulator circuitry which follows the output of IC 302. At the same time, RF-signal is applied to the 1-H delay line from the output of the mixing amplifier. Thus, at the output of the 1-H delay line (pin 7 of IC 302), RF-signal that comprises the previous line's video information is always available. In the event that an imperfection in the tape causes loss of RF-signal input to IC 302, the dropout detector circuit senses the drop in RF-signal level (approximately minus 20 dB) so that anytime the instantaneous RF signal drops 20-dB below normal, an electronic switch in the chip closes and substitutes the "1-H delayed" signal for the attenuated input RF signal. Thus, the white or black flash that would result from the dropout is replaced by video information from the previous line and so the effect of the dropout is largely hidden. Consequently, the usable life of the recording tape is extended because the most noticeable effect of wear on the video tape is an increasing number of dropouts. It is interesting to note the signal being recirculated in the 1-H delay line can replace three to four lines of video before the effect becomes extremely noticeable in the playback picture.

RF output from IC 302 is applied to low-pass filter FL 304 to remove any second harmonic content in the RF signal. Filter output drives buffer transistor TR 310 whose output is applied to pin 14 of IC 303 — input signal is viewable at test point TP 305. Contained in this IC is a series of limiter (clipper) stages that remove all traces of amplitude variation in the luminance FM signal. Limiter output then drives an FM demodulator which is a part of this chip.

Demodulated video output from IC 303 passes through filter FL 306 which has a cut-off frequency of 4.1 MHz. Thus, this filter rejects all ripple and harmonic components from the demodulated video signal. Low-pass filter output passes through a de-emphasis network (C363 and R375) into an amplifier consisting of TR 314 and the buffer stage TR 315.

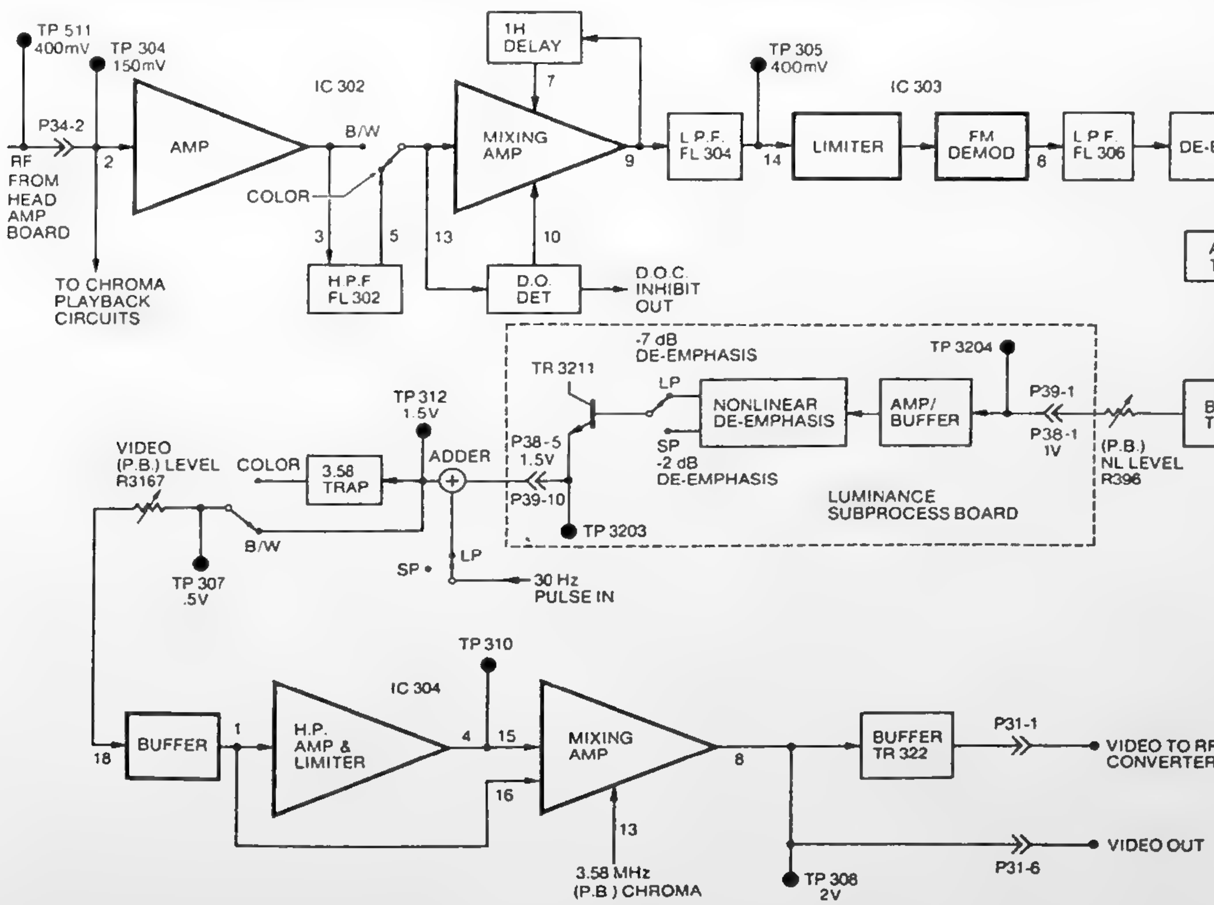


Figure 20. Simplified Luminance Playback Block Diagram

RECORD/PLAY CIRCUIT OPERATION (continued)

Output from the buffer stage is video containing the original 2-hour/4-hour emphasis which was placed on the signal during "Record." From here, the video signal is applied to a Luminance Subprocessing board (via P38-1) which is located on the bottom of the tape deck. On the Luminance Subprocessing board, de-emphasis circuitry (selectable by the 2-hour/4-hour logic) provides additional selectable rolloff of high frequencies, and by so doing restores proper frequency response to the video signal. The output is sent back to the Luminance board via plug P38-5 where it is applied to a trap after passing through an adder stage which introduces a 30-Hz pulse to cancel the DC level shifts in the picture that were produced by the FM interleave circuit during 4-hour "Record." The output of the adder, which is now video information, is viewable at test point TP 312. Following the adder stage, black and white or color mode video is either directly routed to a buffer stage located in IC 304 (via pin 18) in the case of black and white, or the signal is applied a 3.58-MHz chroma trap consisting of FL 307 and associated components. As previously discussed, electronic switching determines whether the path is direct or through the filter. In either case, the video signal input to the buffer amplifier on IC 304 is viewable at test point TP 307. Also, notice in the illustration, that **video level** control R3167 is used to set the input to the IC 304 buffer stage.

Also included in IC 304 is noise-inverter circuitry similar to that used in conventional television instruments. A sample of the video signal is taken from the buffer, sent through a high-pass amplifier (an amplifier with peaked high frequency response) which amplifies the noise component of the video. Output of the high-pass amplifier is fed into a limiter stage in the chip which removes all low frequency components from the video signal, leaving only noise. Limiter output emerges from the chip via pin 4 into additional limiting circuitry consisting of a pair of clipper diodes that set the maximum amplitude of the noise signal. Output signal from limiter diodes D305 and D306 is inverted noise which is fed back to the mixing amplifier via pin 15 of the chip where it cancels the noise in the video signal. Consequently, the output from the mixing amplifier (IC 304 pin 8) is relatively noise-free video — 2V p-p signal is viewable at TP 308. It is also interesting to note that the mixing amplifier in IC 304 is the point where the chroma signal from the chroma processing circuitry is reintroduced to the video. Chroma signal coming from the chroma circuits is input to the mixing amplifier at pin 13 of IC 304.

The luminance output signal, which is now combined with the chroma signal, form composite color video at an amplitude of 2V p-p and is routed to the video-output jack on the rear of the instrument via P31 pin 6. The same signal after some additional phase compensation in transformer T307 is applied to a buffer stage consisting of transistor TR 322 whose 2V p-p output is fed to the RF converter through P31 pin 1.

Chroma Playback Circuits

As can be seen in Figure 21, RF signal (head-amplifier output) is applied to the Luminance board via P34-2. At this point, the RF signal is directed to the luminance and chroma circuits. Following the chroma signal path, the RF signal drives amplifier transistor TR 327 whose output is applied to the ACC amplifier on the Chroma board (via low-pass filter FL 308 and electronic switch transistor TR 326) — signal observable at TP 309.

Once the signal is on the Chroma board, it is viewable at test point TP 801 as the ACC-amplifier input signal to IC 801 pin 13. The ACC amplifier system of IC 801 acts to minimize level changes in the chroma signal that might be attributed to differing tape characteristics and/or physical defects in the tape. Output from the ACC amplifier (TP 803) is applied to a balanced modulator which is part of the same chip via pin 3. Also entering the balanced modulator via pin 5 is 4.2-MHz CW signal. In playback, the balanced-modulator output is the difference between the 629-kHz down-converted chroma and the 4.2-MHz CW signal which is 3.58-MHz up-converted chroma. Balanced-modulator output is via IC 801 pin 7 — signal is viewable at TP 805. In playback, the 3.58-MHz regenerated chroma signal drives buffer transistor TR 802 whose output can be observed at TP 815.

Up-converted chroma is then applied to TR 807, a 2-hour/4-hour switchable 6-dB burst-attenuation stage. In the 2-hour mode, burst is attenuated by 6 dB because it was originally boosted by 6

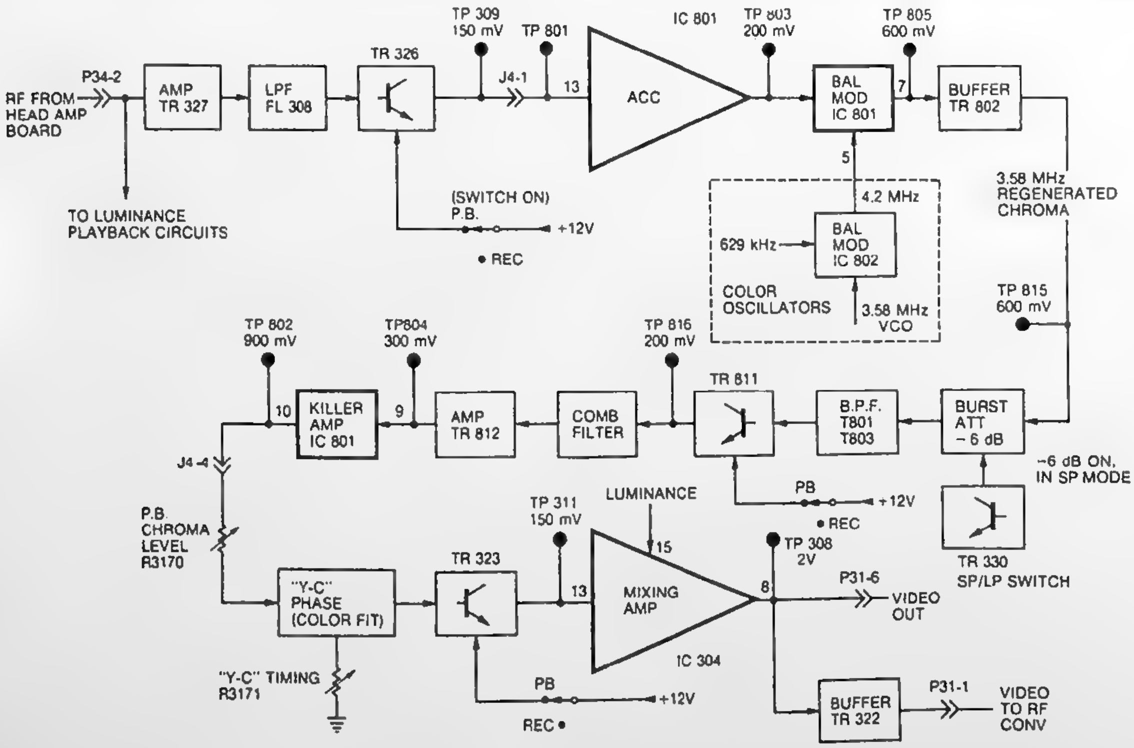


Figure 21. Simplified Chroma Playback Block Diagram

RECORD/PLAY CIRCUIT OPERATION (continued)

dB during "Record." In the 4-hour mode, this stage merely serves as a chroma amplifier. After passing through a 3.58-MHz bandpass filter (T801 through T803), filtered chroma (TR 807 signal) drives a playback comb-filter circuit via electronic switch transistor TR 811 which is turned "on" during playback — switch output is viewable at test point TP 816.

The comb filter is a rather sophisticated circuit that utilizes a "1-H delay line" in conjunction with the chroma rotary-phase recording technique to minimize chroma crosstalk in the color video signal. Conceptually, the chroma rotary-phase system is designed to assure that the chroma crosstalk component is always out of phase with the desired signal. Because of the line-to-line redundancy of the color information in the picture, it is possible, by use of a 1-H delay line, to add the chroma signal from the chroma processing circuit along with chroma from the previous line (1-H delayed) to obtain twice the amplitude of chroma and cancel the crosstalk. Obviously, this is a highly simplified explanation of the chroma rotary-phase and the comb-filter circuits. Nevertheless, for most servicing purposes, this explanation of circuit operation should be adequate.

Chroma from the comb filter drives amplifier transistor TR 812 whose output signal (TP 804) is applied to IC 801 pin 9 where it passes through a killer-amplifier stage that enables or defeats the chroma circuits in the presence or absence of color signal. Output from the killer-amplifier emerges from the chip at pin 10 and is directed to the Luminance board via jumper J4 — signal viewable at test point TP 802. Once the chroma signal is back on the Luminance board, it passes through the **playback level** control (R3170) which allows adjustment of the playback chroma amplitude.

Chroma signal is then directed to the "Y-C" phasing circuit. Basically, the "Y-C" phasing circuit consists of phase-shift components in conjunction with **"Y-C" timing** control R3171. The purpose of this circuitry is to allow adjustment of luminance/chrominance timing — color fit. Network output passes through a playback electronic switch (transistor TR 323) whose output is matrixed with the luminance signal in the mixing amplifier of IC 304. Chroma input signal can be observed at TP 311. Once the chroma signal is mixed with luminance, it follows the previously described path to the RF modulator or to the external video-output jack.

COLOR OSCILLATORS

As shown in Figure 22, the VBT200 uses three separate oscillators to process the chrominance signal. These are the 3.58-MHz XTAL oscillator, (crystal oscillator), 3.58-MHz VXO (variable crystal oscillator), and the 2.517-MHz VCO (voltage-controlled oscillator). The functions of each will be described in the following text. As previously learned, the 3.58-MHz chroma information is down-converted (hetrodyned) to 629 kHz in the "Record" mode by beating the signal against a 4.2-MHz CW signal in a balanced modulator (mixer) circuit.

Not only is the "Record" chroma signal down-converted to 629 kHz, but it is also recorded in a configuration where on the first field (Head-1 pass) the phase of the chroma signal is advanced 90° per line. When the second field is recorded (Head-2 pass) the chroma signal is retarded in phase by 90° for each horizontal line. This system of chroma signal recording is called "chroma rotary-phase" recording. As was learned, this system of chroma recording allows a comb-filter circuit in the playback electronics to effectively cancel chroma crosstalk signal which is present in "LP" recordings because there is a negative guard band in the LP mode.

In order to accomplish the chroma rotary-phase recording technique, the 4.2-MHz signal used to down-convert the chroma information must change phase by 90° each horizontal line. Thus, this signal must somehow be keyed by the horizontal sync pulse. It

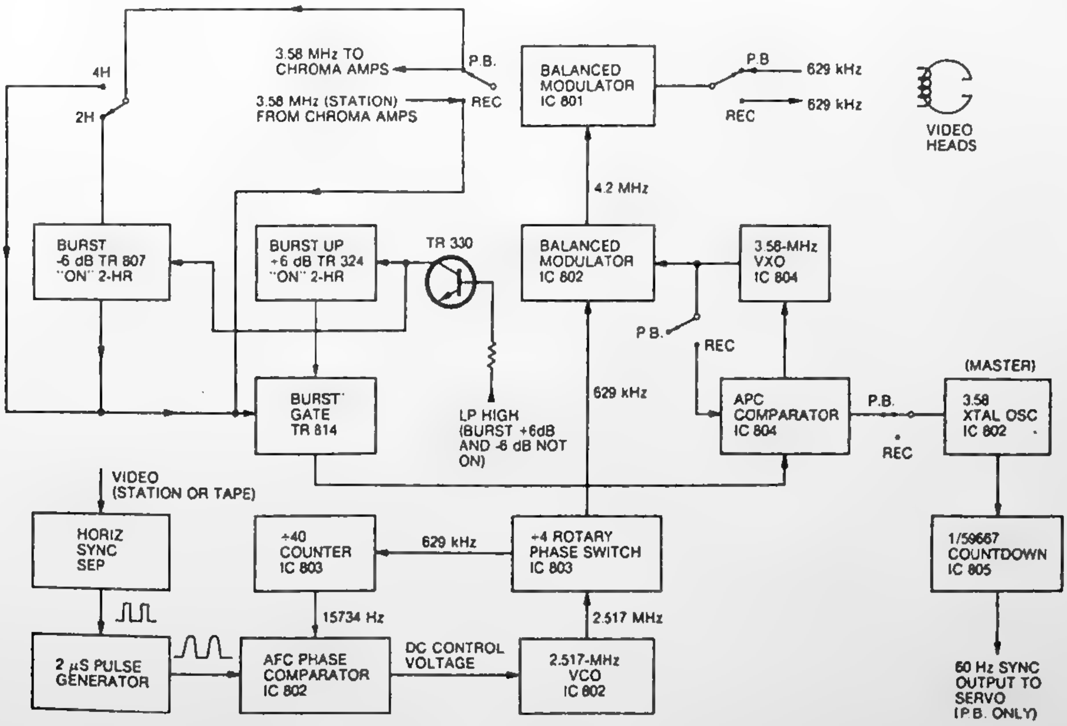


Figure 22. Simplified Color Oscillators Block Diagram

RECORD/PLAY CIRCUIT OPERATION (continued)

has been learned that the 4.2-MHz CW signal is actually produced by beating together a 3.58-MHz signal obtained from the variable crystal oscillator (VXO) and a phase-rotary 629-kHz signal. These signals are hetrodyned in a second balanced modulator (mixer) and the sum of the two frequencies is the 4.2-MHz CW signal used to **down-convert** the chroma to 629 kHz. During "Record," the 3.58-MHz VXO is locked to the input signal burst by an APC (Automatic Phase Control) system similar to that used in color television receivers. The 629-kHz rotary-phase CW signal is extracted from a ÷4 counter clocked by a 2.517-MHz signal produced by the voltage-controlled oscillator (VCO) which is phased locked to the "Record" signal horizontal sync pulse.

In Playback, the 629-kHz down-converted chroma signal is **up-converted** back to the 3.58-MHz frequency by using the same oscillators and balanced modulators in reverse. The incoming 629-kHz signal is applied to the balanced modulator where it is beat against 4.2-MHz phase-rotary CW signal. The difference frequency (3.58 MHz) is the regenerated chroma signal. During Playback, the 3.58 VXO (beats against 629-kHz phase-rotary CW to produce 4.2 MHz for up-conversion) is referenced to the 3.58-MHz XTAL (crystal oscillator).

The APC circuit associated with the 3.58-MHz VXO receives output from the 3.58-MHz XTAL oscillator as a reference and the burst component of the up-converted 3.58-MHz color signal is compared against this locally generated 3.58-MHz reference signal to generate an error voltage that is used to correct 3.58-MHz VXO phase and frequency so that the output 3.58-MHz chroma signal has a high degree of phase stability. Also during Playback, the **2.517-MHz VCO** is locked to playback horizontal sync. By so doing, any **jitter** component present in the playback signal which could adversely affect chroma phase (color hue) can be cancelled by introducing this jitter component **"out of phase"** into the 629-kHz rotary-phase chroma. At the same time, the horizontal sync pulse triggers the gated counter circuit to produce the appropriate phase of chroma signal necessary to properly up-convert the chroma signal.

Examination of the **Color Oscillators** block diagram at the end of this section shows that four integrated circuits (IC 801, 2, 3, 4) provide most of the circuitry required for up-conversion and down-conversion of the chroma signal during Playback and Record respectively. Contained in IC 802 is the 3.58-MHz XTAL (crystal) oscillator whose output is observable at TP 807. During "Record," this oscillator is inactive — switched "off." The other oscillator contained in IC 802 is the 2.517-MHz VCO and its associated phase-comparator circuit. Output from the VCO (IC 802 pin 17) is fed to pin 6 of IC 803, the gated counter circuit which produces the rotary-phase 629-kHz CW signal. One of the 629-kHz signals is applied to a ÷40 counter in the chip to produce a horizontal frequency signal which leaves the chip at pin 2 to provide an "FH" (horizontal frequency) feedback signal to the phase-comparator circuitry located in IC 802. This signal enters the chip at pin 18. The other input to the AFC phase comparator is the 2-μs pulse which is timed by horizontal sync. This signal is produced by circuitry in IC 803 and emerges from the chip at pin 14. The 2-μs pulse (TP 811 signal) is sent to the phase-comparator circuitry in IC 802 and enters the chip at pin 7. Thus, this feedback loop locks the 2.517-MHz VCO to a multiple of 160 times the horizontal scan frequency — 2.517440 MHz.

This signal, as previously mentioned, is supplied to pin 6 of IC 803 where it is counted down to a nominal 629 kHz (629.360 kHz) in the chip. Then, appropriate gating circuitry selects the proper output from the counter to provide a signal that represents phase zero with respect to the chroma signal phase +90°, +180°, +270°, etc. or a phase 0°, −90°, −180°, −270°, etc., depending upon which head is on the tape at the particular time.

The direction of phase rotation, being related to which head is on the tape at a given time, can be determined and preset by sensing whether the PG pulse is positive-going or negative-going. As shown in the block diagram, the cylinder PG (pulse generator) pulse from J1 pin 1 is applied to pin 7 of IC 803 where it serves to select the direction of rotation for the four-bit counter. The outputs of the four gates which select the appropriate counter signal phase are summed together into a single 629-kHz rotary-phase signal which emerges from the chip at pin 4. This output signal is sent back to the balanced modulator stage in IC 802 where it beats with 3.58-MHz CW from the 3.58-MHz VXO (Variable Crystal Oscillator) contained in IC 804. Output from the balanced modulator in IC 802 emerges at pin 12 as a nominal 4.2-MHz signal — 4.208905 MHz exact frequency. This signal is fed to the balanced modulator contained in IC 801 where the actual conversion of chroma information is performed. The VXO contained in IC 804 is locked to the input chroma-signal burst during "Record" by comparing its output to burst in an APC circuit. 3.58-MHz burst signal enters IC 804 at pin 3.

Transistor switches consisting of TR 815 and TR 816 make the selection of which signals are compared to lock the oscillator during Record and Playback. During "Record," 3.58-MHz VXO output emerges from the chip at pin 14 and is applied back to the APC circuit via transistor switch TR 815. The other signal applied to the APC system is burst which is applied via burst-gate transistor TR 814 and some limiter circuitry into chip terminal 6. This burst signal is observable at TP 813. During Playback, switch TR 816 is turned "on" to supply reference signal from the 3.58 XTAL oscillator located in integrated circuit IC 802. This signal (from TR 816) is applied into pin 3 of IC 804. The other signal (up-converted playback signal burst) enters the phase comparator via IC 804 pin 6. Thus in Playback, the regenerated chroma signal is phase-locked to the locally generated 3.58-MHz signal provided by the 3.58-MHz crystal oscillator contained in IC 802. The crystal oscillator in IC 802 also drives a frequency counter (IC 805) which counts the 3.58-MHz signal down to 60 Hz to provide a reference signal to lock the cylinder servo system during Playback.

CYLINDER AND CAPSTAN SERVO OPERATION

The servo systems used in the VBT200 are used to control the operation of the video-head cylinder and capstan-drive motors by sensing an error in operation and issuing a control signal that corrects the operation. Two servo systems are used in the VCR. They are the capstan servo system and the cylinder (headwheel) servo system. These servos have two modes of operation — "Play" and "Record."

In the "Record" mode, television vertical sync is the reference for the cylinder servo. The feedback signal is a pulse signal taken from the cylinder P.G. (pulse generator) which provides an accurate indication of where the video heads are on the tape at all times, and which head is in contact with the tape. During "Play," it is only necessary that the headwheel rotate at a constant 1800 RPM. Consequently, a 60-Hz reference signal is supplied by a counter circuit that operates from an internal 3.58-MHz crystal oscillator.

The capstan servo system which controls the actual movement of tape through the machine also has two modes of operation. During "Record," the capstan servo system simply functions to transport the tape through the machine at a constant speed. The reference signal for the capstan servo system is the previously described trapezoid waveform derived from the cylinder P.G. pulse. Thus, the capstan servo system locks to the headwheel rotation. The sample pulse (indication of capstan motor operation) is a signal derived from the capstan F.G. (frequency generator) which is divided down to 30 Hz in **Standard Play** (SP) mode or 15 Hz in **Long Play** (LP) mode. Comparison of this signal with the trapezoid reference indicates variations in motor speed. Therefore, the feedback control system can lock the capstan motor to a constant speed.

During playback, the reference signal remains the same (trapezoid derived from cylinder P.G.); however, the feedback signal now becomes the control-track signal which is recorded along the bottom edge of the tape. When the tape is recorded, the control-track signal is produced by a 30-Hz frequency counter (flip-flop) which is locked to television vertical sync. Thus, the capstan servo system can sense any deviation in machine speed by timing the arrival of control-track pulses. Furthermore, because during "Record," the position of vertical sync on the tape is accurately determined, and because the control pulse is coincident with vertical sync on the tape, it is possible to provide a vernier control of tape transportation speed so that the capstan servo system can accurately move the tape in such a manner that the recorded video tracks on the tape align themselves perfectly with the path of the rotating video head assembly.

Cylinder Servo System

The cylinder servo system shown in Figure 24 has two basic feedback control loops. The first loop (shown at the bottom of the **Cylinder Servo** block diagram) is the speed control loop which maintains the headwheel rotation at very nearly the nominal 1800 RPM. Headwheel speed is sensed by sampling output from the D-D motor F.G. assembly. This is a 1.8-kHz sinewave signal which is applied to a frequency amplifier whose output is shaped into a 900-Hz squarewave by a ÷ 2 counter.

The squarewave signal is applied to a logic "AND gate" along with the output of a standard-time generator. The standard-time generator is a one-shot multivibrator whose pulse width is preset by the **cylinder free-running speed** control. This constant width pulse is compared with the pulse produced by the cylinder F.G. in an "AND" gate. The output of the gate is the difference between

	MODE	REFERENCE SIGNAL	SAMPLE SIGNAL
(CYLINDER)	REC	V-SYNC	CYLINDER P.G.
	PLAY	REFERENCE SIGNAL MADE FROM 3.58 MHz (60 Hz)	
TAPE SPEED CONTROL (CAPSTAN)	REC	CYLINDER P.G.	CAPSTAN F.G. DIVIDER OUTPUT (SP: 30 Hz LP: 15 Hz)
	PLAY		RECORDED CONTROL SIGNAL

Figure 23. Servo Systems Reference and Sample Signals

CYLINDER AND CAPSTAN SERVO OPERATION (continued)

these two pulses. Assuming that the motor tends to run fast, the width of the gate input pulse (motor-speed sample) becomes narrower; thus, the output pulse which represents the difference between the sample pulse and the standard-time generator pulse also becomes narrower. The gate output pulse is integrated (filtered) to provide a DC signal to a motor drive circuit. In the event that the motor slows down, the pulse width becomes wider, more motor drive is produced, and the motor speeds up. In this way, the motor speed is maintained very close to 1800 RPM.

The top section of the block diagram shows the phasing (position) control part of the servo system. During "Record," video signal is applied to a sync separator which separates out the 60-Hz vertical sync pulse. Vertical sync is applied to an amplifier and through a ÷ 2 counter to produce a 30-Hz squarewave signal. This signal follows two paths. One path is an additional amplifier that generates the 30-Hz squarewave control-track signal which is recorded along the bottom edge of the tape. The other path is through a time delay (one-shot multivibrator) circuit which allows the video heads to be phased with respect to vertical sync. The output of this stage, known as the "record shifter," is a narrow sample pulse which is applied to a sample and hold circuit as the reference signal.

The feedback signal (represents speed and position of the headwheel) is taken from the cylinder motor pulse generator coils (P.G.). This 30-Hz signal tells two things — which head is on the tape and where the head is on the tape at any particular instant. After passing through a pulse-amplifier circuit and a "one-shot" delay, the signal drives a trapezoid generator. (The trapezoid signal is a waveform that has a definite leading edge rise time and a definite trailing edge fall time.) This signal is also applied to the sample and hold circuit. When the headwheel motor speed and phasing are exactly right, the trailing edge of the trapezoid is sampled at its midpoint. Each time a sample is taken, it is held as a DC voltage in the sample and hold circuit. Output of the sample and hold circuit is fed to the standard-time generator and it determines the pulse width of the pulse applied to the "AND" gate. Thus, by varying the width of this pulse, it is possible to provide a small increment of speed control necessary to accurately position the heads on the tape.

Assume for a moment that the headwheel is running slightly slow. In this instance, the sample will be taken at a higher point on the trapezoid resulting in more DC voltage output from the sample and hold circuit. This is translated into a change in conduction time of the standard-time generator such that the comparison process in the gate provides a signal to speed up the motor. The converse is true if the headwheel is running slightly fast. In this instance, the sample is taken lower on the ramp and the motor is ordered to slow down.

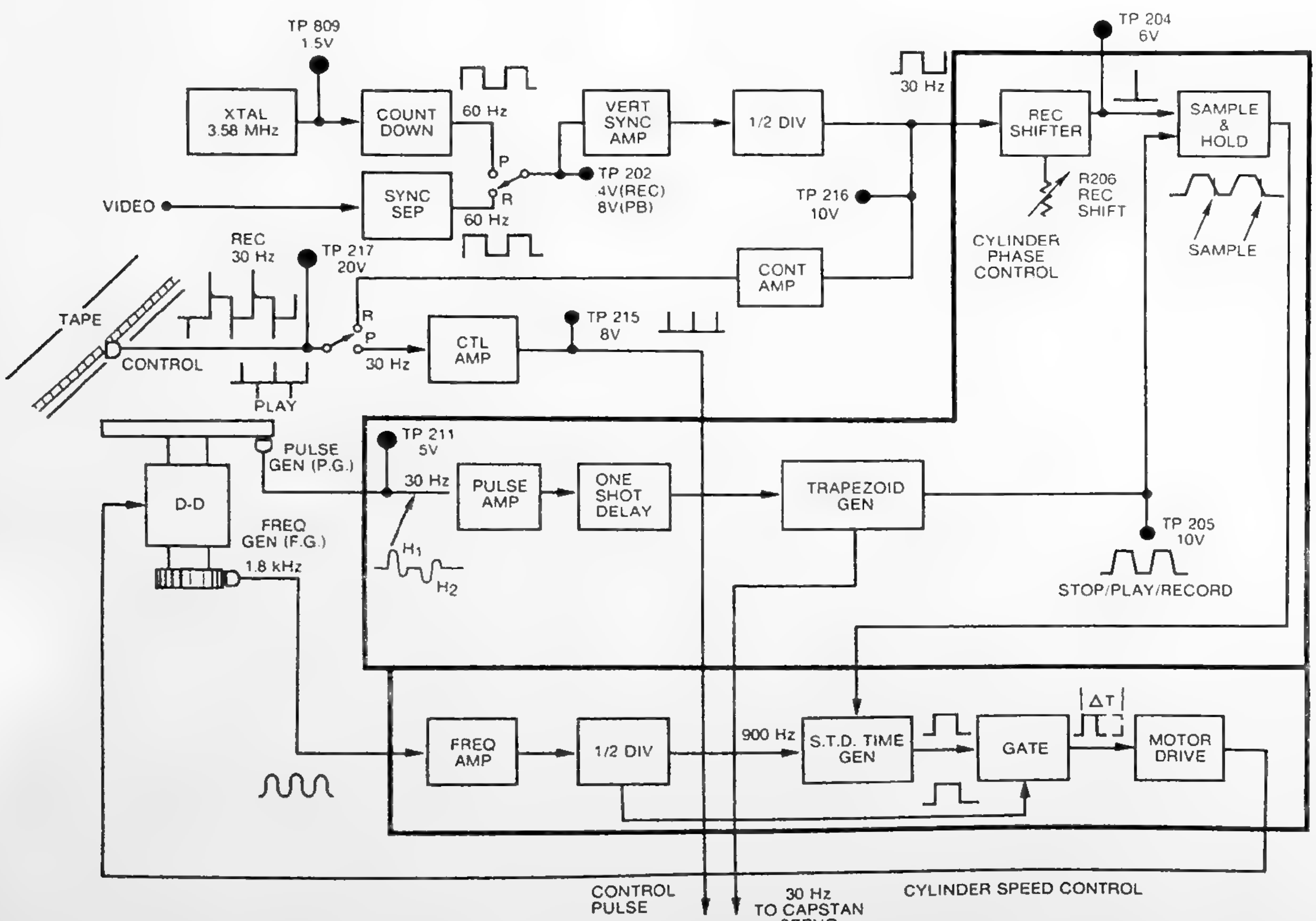


Figure 24. Cylinder Servo System

CYLINDER AND CAPSTAN SERVO OPERATION (continued)

Capstan Servo System

The capstan servo circuitry is similar to that used for the cylinder servo. Again, two loops are used — a speed control loop and a position or phasing control loop. Capstan motor speed is sensed by the capstan F.G. assembly which produces a sinewave of 480-Hz in the LP mode and 960-Hz in the SP mode. After amplification and processing by ÷ 2 counter, a 240-Hz (LP mode) or 480-Hz (SP mode) squarewave is available as input signal to a standard-time generator/"AND" gate circuit similar to that of the cylinder servo. When the capstan motor is running at the correct speed, the input signal to the standard-time generator/"AND" gate circuit is 240 Hz. Notice that in the LP mode, the 240-Hz signal is available at the output of the first divider. When the machine is operated in the SP mode, an additional frequency divider in the circuit forces the capstan motor to run at twice the speed in order to supply the 240-Hz input to the standard-time generator/"AND" gate circuit.

Output of the gate is a pulse representing the difference between the standard-time generator and the input squarewave representing motor speed. This pulse is integrated and applied to the motor drive system so that the entire circuit stablizes at roughly the correct speed. In a similar manner to the cylinder servo system, the pulse width of the standard-time pulse is modified by the second part of the loop which is the phase control circuitry.

In "Record," the capstan motor provides constant tape transportation speed. In this mode of operation, the feedback signal representing motor speed is taken from the output of the second frequency divider in the speed control chain. Thus, after passing through a divide by 8 counter, a squarewave signal of 30-Hz (SP) or 15-Hz (LP) is available to represent motor speed. This signal, after processing by a pulse amplifier and some delay circuitry, is a sample pulse which is applied as one input to the sample and hold circuit. The reference signal input to the sample and hold circuit is manufactured from the 30-Hz trapezoid produced by the cylinder P.G. As with the cylinder servo, the output of the sample and hold circuit is a DC voltage which represents small increments in speed (phase) changes in the capstan motor operation. This DC voltage is applied to the standard-time generator to modify the pulse width and thus produce a vernier change in motor speed.

During "Playback," the 30-Hz control-track pulse on the video tape is applied to the pulse amplifier in place of the output of the divide by 8 counter. This signal (after processing) becomes the sample pulse. Thus, any changes in transportation speed are sensed by a change in the sample point so that the changes in output of the sample and hold circuit provide appropriate DC control to the capstan motor to correct for the speed/position errors.

Three-phase Fullwave Bilateral Drive Circuit

One of the difficulties in designing a good video tape recorder for home use is to very accurately control the operation of the video scanning process. Most industrial video tape recorders, as well as many of today's home video recorders, employ a belt drive system to operate the headwheel. In principle, the belt drive system drives the headwheel at a speed slightly faster than the nominal 1800 RPM. Locking the headwheel then depends upon use of a servo controlled braking system that drags the headwheel down to the required exact 1800 RPM — depending upon belt slippage to provide the degree of isolation between the main drive and the servo-controlled headwheel. Although this system works well enough with some TV receivers, with others problems of horizontal instability (jitter) appear. Furthermore, the headwheel assembly in many of these recorders is rather massive and is thus difficult to accurately servo control because of the inertia of the rotating mass.

In the RCA VBT200 VCR, a direct-drive motor system, used in conjunction with a relatively low mass headwheel assembly, provides very precise control over headwheel rotation; thus, assuring very accurate horizontal time base timing and freedom from horizontal

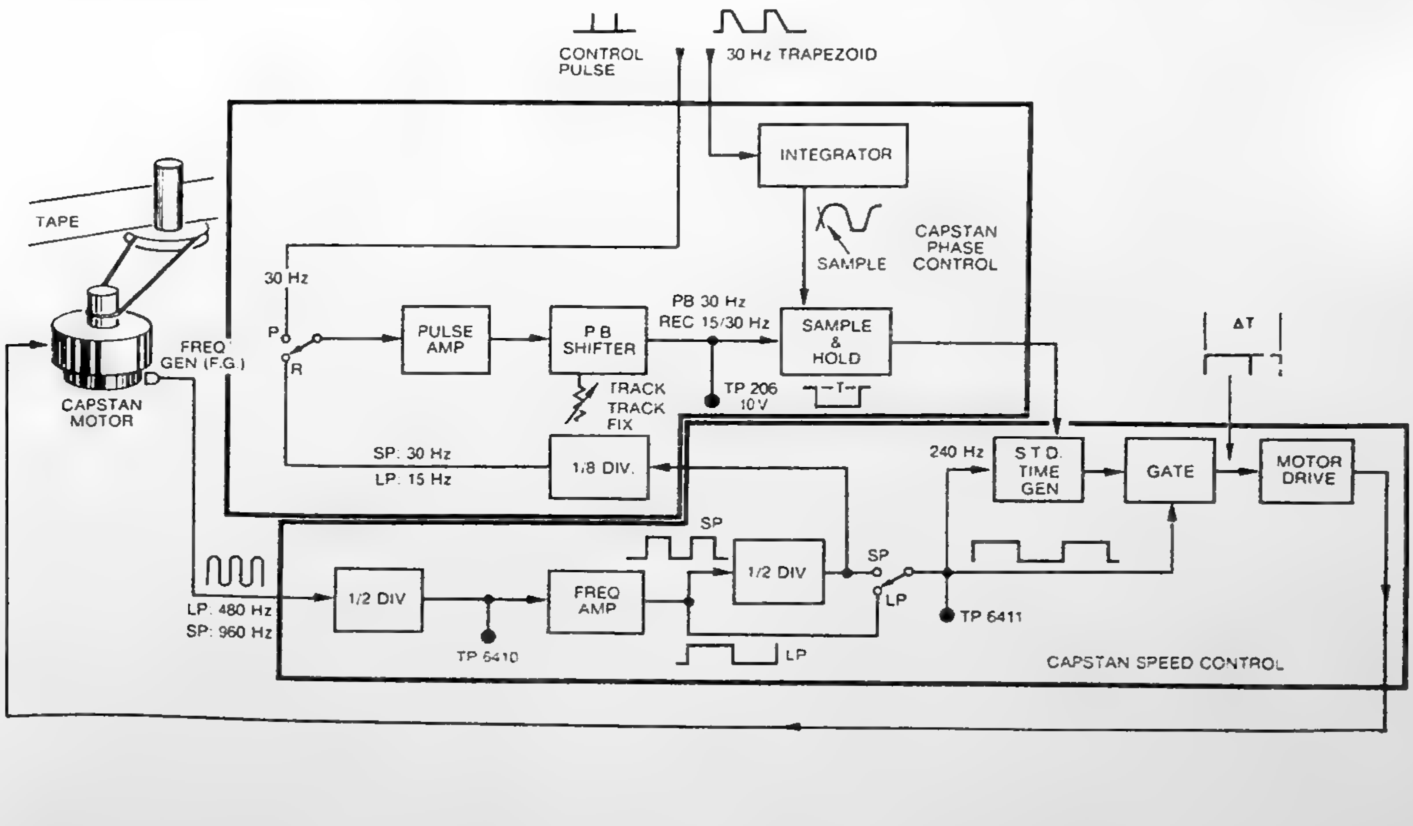


Figure 25. Capstan Servo System

CYLINDER AND CAPSTAN SERVO OPERATION (continued)

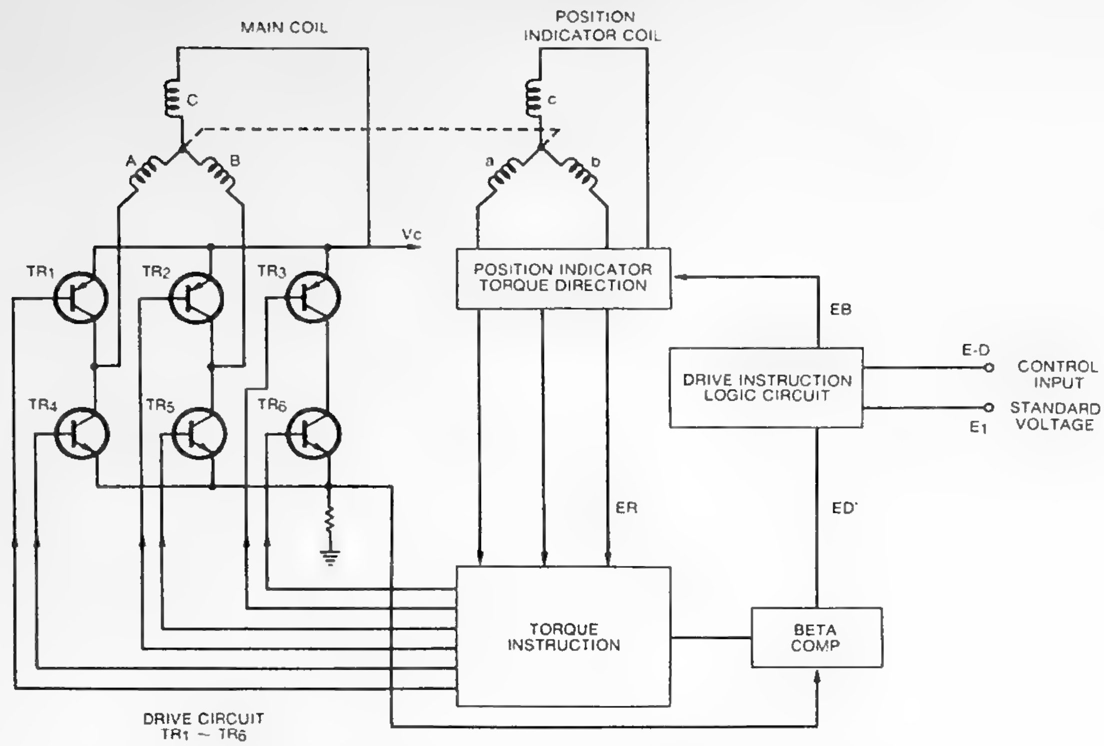


Figure 26. D-D Motor Three-Phase Inverter Block Diagram

problems in nearly all TV sets. To accomplish the objective of providing very close control of the headwheel motor, an entirely new drive concept was invented and this is the direct-drive (D-D) cylinder assembly used in the VBT200.

Although at first glance the motor might appear to be simply a 12-volt DC motor, it is far from that. In reality, the motor used to drive video heads in this machine is a multipole three-phase motor that is driven by a very precisely controlled three-phase AC inverter. The windings, called the main coils of the motor, provide the motive power to drive the motor. Feedback necessary to sustain oscillation of the three-phase invertor is sampled by position indicator coils designed so that the feedback signal always tells the torque instruction circuit which transistor combination should be turned "on" next to sustain rotation of the motor.

The motor speed is modified by control input from the cylinder-servo system which is compared against a standard voltage in the drive instruction logic circuit. The output of the drive instruction logic circuit then is applied to position indicator, torque direction circuitry, and torque instruction circuitry so that the rotation of the motor becomes locked to the cylinder-servo system instructions.

CYLINDER SERVO SYSTEM DETAILS

As previously learned, the cylinder servo system operates differently in "Record" and "Play." Figure 27 shows that in the "Record" mode, the cylinder servo is locked to vertical sync taken from the sync separator — located on Chroma board. Input sync is applied to an amplifier stage in IC 201 via plug 21 pin 3 and the **record/playback** switch. In the Playback mode, the cylinder runs at a constant 1800 R.P.M. because it is locked to a 60-Hz signal obtained via a countdown chip clocked by the 3.58-MHz crystal oscillator on the Chroma board. In either case, the output of the IC 201 amplifier is applied to a ÷ 2 counter (MM — one-shot multivibrator) which outputs a 30-Hz signal at pin 26 of the chip. This 30-Hz signal supplies the control track signal during "Record." as-well-as furnishing input (via chip pin 21) to the record shifter one-shot multivibrator (MM). Record shifter output is at pin 18 of the chip. This signal, after differentiation into a narrow pulse, is applied back into pin 14 of the IC to act as the sample pulse for the sample gate. (The record shifter stage is an adjustable time-delay circuit that allows the vertical-sync pulse to be physically positioned on the tape so that it occurs soon after head switching during playback.)

The other signal used in the sampling process is a 30-Hz trapezoid. This signal is generated by the cylinder PG (pulse generator) circuit. The cylinder PG signal is an alternating positive and negative pulse taken from the PG magnetic pick-up located in the D-D motor assembly. The PG signal enters the servo system through the Motor Drive board which contains a differentiator circuit and amplifier that receives input via P27-1. Output from transistor TR 2115 is a positive pulse signal when head-one contacts the tape and a negative pulse when head-two contacts the tape. These pulses are fed to the Servo board through wire jumper J2 — input signal is viewable at TP 211. Following TP 211, the positive pulse and the negative pulse are separately processed.

The positive pulse is applied to IC 201 pin 2 (via diode D206) where it triggers one of the two PG-shifter one-shot multivibrators (MM). Output of this one-shot multivibrator triggers **(sets)** a flipflop (FF) in IC 201. The other PG shifter multivibrator located in IC 202 is triggered by the negative PG pulse which is inverted by transistor TR 211. Transistor T211 signal **resets** flipflop "FF" in IC 201.

CYLINDER AND CAPSTAN SERVO OPERATION (continued)

Output from flipflop "FF" is a 30-Hz squarewave signal in which the duty-cycle of the positive and negative half-cycles are variable via the individual **PG shifter** controls. This signal (viewable at TP 201) drives a trapezoid generator which is an integral part of IC 201. The 30-Hz PG signal also provides head-switching signals to turn "on" the individual head preamplifiers on the FM Modulator/Head-Amplifier board.

The PG flipflop output is applied to the trapezoid generator via IC 201 pin 15. The trapezoid generator generates a 30-Hz trapezoidal signal that is timed so that the previously described sample pulse (IC 201 pin 14) samples the center of the trailing edge of the trapezoid signal when the headwheel (upper cylinder) is running at the correct speed and locked to the system signals. Sample-gate action can be viewed with a dual-trace scope by scoping test points TP 204 (sample gate-pulse signal) and TP 205 (trapezoid signal).

The sample gate output (IC 201 pin 12) is a DC voltage of approximately +6.5V which swings "up" or "down" depending upon where the sample is taken on the trapezoid, as determined by the physical position of the heads on the video tape at the instant of sampling. This voltage, limited by diodes D209 and D210, is applied to pin 10 of IC 202 where it modifies the pulse width of a one-shot multivibrator (MM) which serves as the standard-time generator. Associated with this one-shot multivibrator is the **cylinder free-run** control whose adjustment sets the pulse width of the standard-time generator so that the cylinder free-running speed is very close to 1800 R.P.M. Standard-time generator output (IC 202 pin 2) is sent to a logic "AND" gate located on the Motor-Control board via jumper J1.

Contained on the Motor Drive board is the motor speed control circuitry associated with the cylinder motor FG (frequency generator) pick-up. As was learned, the cylinder motor FG signal is a 1.8-kHz tone which is applied to the input of a three-transistor "FG amplifier" — transistors TR 2101, 2, 3. (The input signal is observable at TP 2101.) FG-amplifier output is counted down to 900 Hz by counter IC 2101. The 900-Hz output is applied to gate transistor TR 2104 and also fed back to pin 12 of IC 202 on the Servo board where it triggers the standard-time generator (one shot) contained in the IC. Also entering the standard-time generator is the output of the phase-control circuitry of IC 201 (pin 10 of IC 202) along with the cylinder free-run control voltage. The combination of the bias introduced by **cylinder free-run** control (R245) and the DC phase-control signal sets the output pulse width of the standard-time generator — output is via pin 9 of IC 202. This signal is sent back to the gate transistor (TR 2104) on the D-D Motor Drive board via jumper J1.

Recall, that the speed-control gate (TR 2104) compares the counted down (900 Hz) FG pulse and the standard-time generator pulse, producing an output which represents the time difference between the two. Circuit parameters are such that the output of the filter amplifier (three blocks) that drives D-D motor-control IC 2102 pin 5 is a DC voltage of approximately 4.8 volts when the D-D motor speed is correct and the servo system is locked. The feedback loop conditions are such that if the system is not locked, or the motor is tending to run slow, the DC input to pin 5 of IC 2102 will be somewhat greater that the nominal 4.8 volts. Conversely, if the motor speed tends to be fast, the IC 2102 input will be somewhat lower than the nominal 4.8 volts.

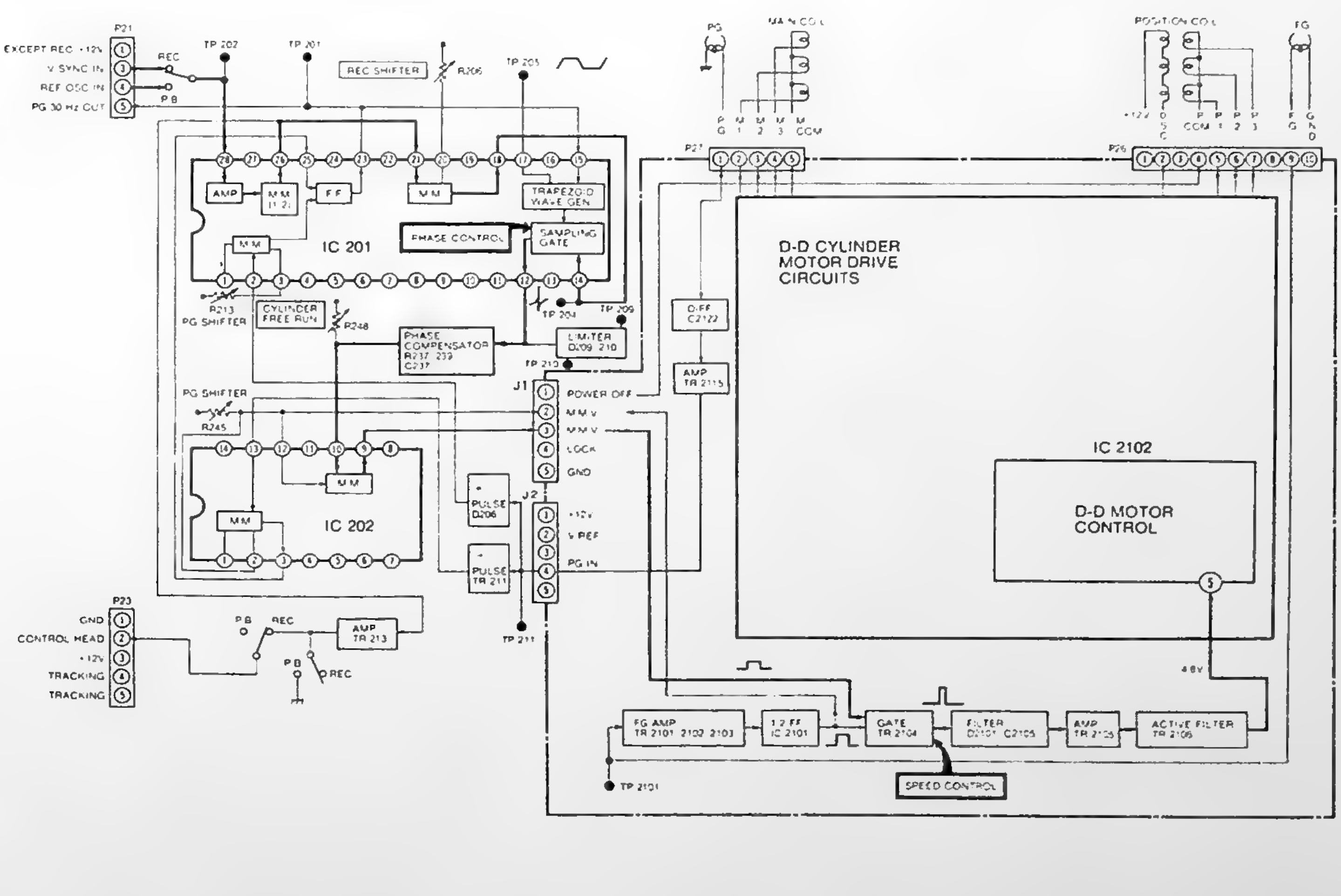


Figure 27. Cylinder Servo Detailed Block Diagram

CAPSTAN SERVO SYSTEM DETAILS

The capstan servo system is similar in concept to that of the cylinder servo. As with the cylinder servo, it has been learned that the capstan servo has two modes of operation. In "Record" mode, the capstan servo system maintains constant tape speed for either 2-hour (SP) or 4-hour (LP) operation. In playback, the system maintains constant speed as-well-as maintaining position control of the tape so that the video heads on the cylinder unit will properly track the recorded information on the video tape.

To maintain constant tape speed in "Record," the capstan servo is referenced to the cylinder PG derived trapezoid signal. The trapezoid signal, after some integration by "ramp-changer" capacitor C218, is applied to sample-gate transistor TR 203 along with the sample-gate signal derived from the capstan PG signal. The sample-gate signal is derived from the counter system on the SP/LP Select board — 30 Hz in "SP" and 15 Hz in "LP." Output from the sample gate is an amplitude-limited DC voltage (limiter diodes D203 and 204) which modifies the pulse width of the capstan standard-time generator (MM) — via IC 201 pin 9. (Basic pulse width is set with **capstan free-run** controls.) Output from the standard-time generator drives a logic "AND" gate, along with the capstan motor FG signal. The output of the speed-control "AND" gate leaves IC 201 via pin 10. This pulse, after integration in a filter network consisting of capacitor C222 and associated components, is base bias for amplifier transistor TR 206. Also associated with amplifier TR 206 is a logic input from the Transport/Control board which indicates that the logical sequences necessary to initiate various modes of operation have been completed before the capstan motor is allowed to operate and move tape. Output from amplifier TR 206 is applied to a three-transistor motor drive circuit that supplies DC voltage to the capstan motor. This voltage leaves the Servo board via P25-3.

The rough speed control of the capstan motor is accomplished in basically the same manner as was described for the cylinder servo. In this case, the capstan FG signal (960 Hz or 480 Hz depending upon the mode of operation) is fed to the Servo board via P25-4 where it is applied as input to a flipflop (FF) contained on IC 201 — input signal is viewable at TP 203. Output of this flipflop (half input frequency) emerges at pin 6 as a 480-Hz or 240-Hz signal (SP or LP) which is directed to the SP/LP Auto Select board via P28-3 An amplifier/inverter stage on the SP/LP board processes the signal to a level sufficient to drive a multivibrator back on the Servo board — part of IC 201 But more importantly, this serves as a pickoff point where the additional stage of frequency division can be switched "in" to apply 240-Hz signal to the standard-time generator when in the "SP" mode.

Also on the SP/LP board is the ÷ 8 counter that produces the capstan pulse generator (PG) signal for input to the servo phase-control circuitry when the unit is in the "Record" mode. A pickoff from this counter supplies the aforementioned SP-mode 240-Hz FG signal.

As previously learned, the 30- or 15-Hz counter output "PG" signal is processed into the sample pulse which samples the trapezoid signal to produce the control voltage necessary to provide correct motor speed — signal frequency is 30 Hz in the "SP" mode and 15 Hz when the unit is in the "LP" mode.

The capstan PG signal enters the Servo board on P25-5 where it is routed to the "Record/Play" switch. When the unit is in the "Record" mode, the signal is amplified by transistor TR 212 and then serves to trigger the tracking shifter one-shot multivibrator part of IC 202. Output of this stage, which interfaces with the **TRACKING** control when the unit is in playback, emerges from IC 202 via pin 7. After some additional processing (differentiation), the signal is applied to the sample gate as the sample pulse — indicative of the motor speed error.

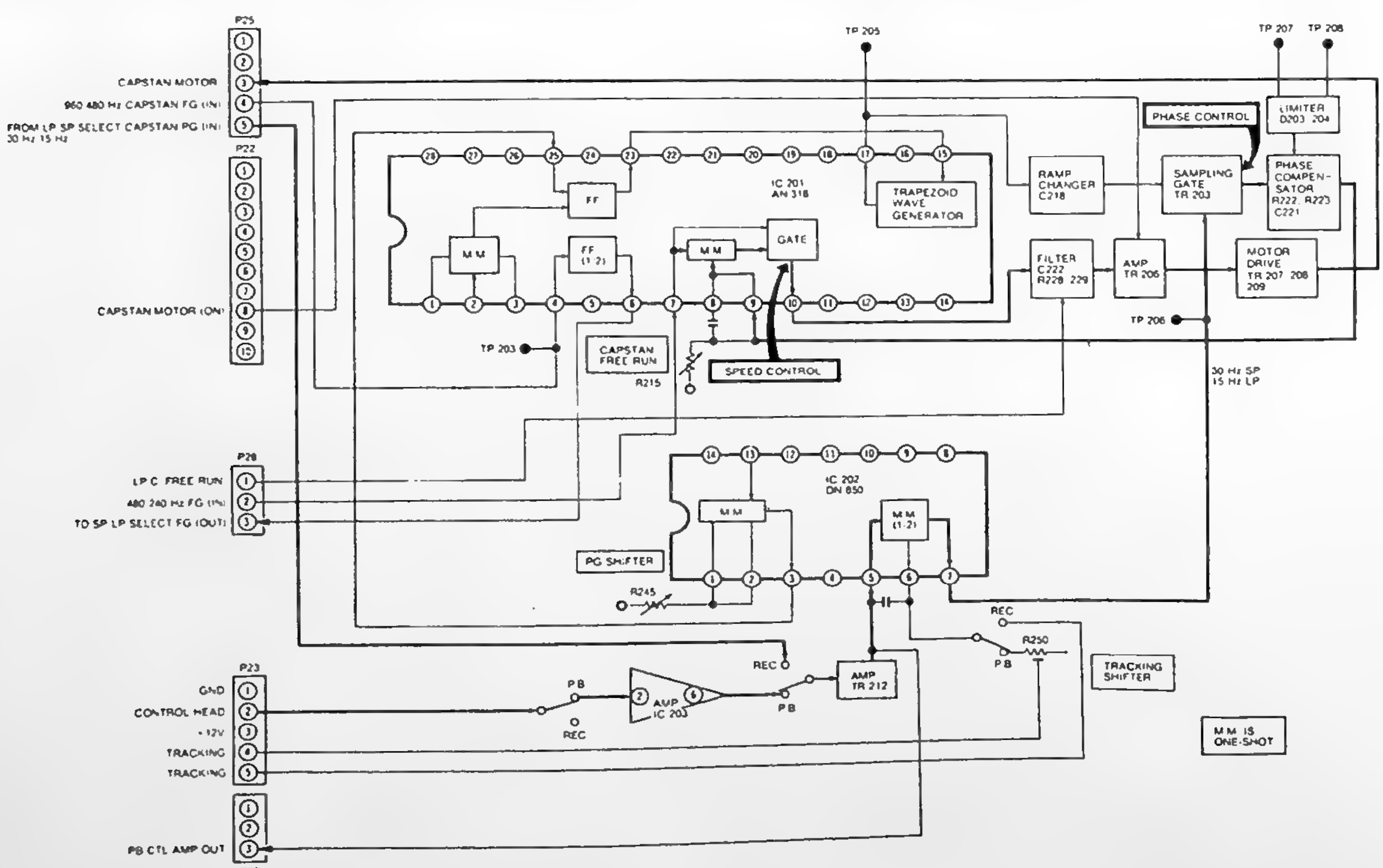


Figure 28. Capstan Servo Detailed Block Diagram

SP/LP AUTO SELECT CIRCUITS

The VBT200 VCR employs special logic and control circuitry to allow the user to manually select 2-hour or 4-hour operation when recording a tape. During playback, logic and timing circuitry samples the control-track signal and directs electronic switching, causing the machine to play back the tape at the correct speed.

In addition to setting the capstan motor speed for SP (Standard Play) or LP (Long Play) operation, the SP/LP Auto Select Circuit controls four additional functions that are necessary for proper SP and LP performance during "Record" and "Playback." Through use of a control voltage known as "LP high" (+12V source in LP-mode), the audio record and playback equalization are changed to optimize frequency response in both modes of operation. Also during the LP Record mode, additional video pre-emphasis is introduced and the "1/2-FH" frequency interleave circuitry is activated. In Playback mode, the "LP-high" voltage switches in complementary video-frequency de-emphasis and an "1/2-FH" interleave cancellation squarewave signal

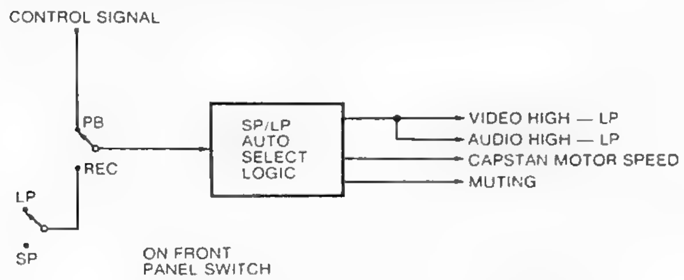


Figure 29. SP/LP Logic Functions

The SP/LP Auto Select board also provides a muting voltage which is present when the machine senses erroneous control-track frequency — indicative of wrong speed operation. For the interval of time necessary for the machine to change speeds and stabilize its operation, the muting voltage is present. Finally, and most important, the SP/LP Auto Select circuitry electronically switches the capstan motor speed from the SP (2 hour) to the LP (4 hour) mode or vice versa.

Capstan Motor Speed Selection

As was learned in the discussion of servo operation, the capstan motor SP/LP speed selection is accomplished by switching "in" or "out" an extra stage of frequency division in the capstan FG (frequency generator) circuit. In order to satisfy the requirements of the capstan servo system, the FG signal input to the standard-time generator and logic "AND" gate must be a constant 240 Hz, as shown in the Figure 30. During "SP-Record," base voltage is applied to transistor TR 6405, causing it to conduct and load down the signal output of amplifier TR 6411. Thus, it can be seen that the signal input to the standard-time generator (viewable at TP 6411 on SP/LP Select board) must come from the output of IC 6403 pin 3 which is an additional ÷ 2 count. Under these conditions, the capstan motor is forced to run at the SP speed.

When LP operation is desired, transistor TR 6406 is turned "on" and thus shorts the signal from the pin 3 output of IC 6403. At the same time, signal from the collector of TR 6405 is applied to the standard-time generator via "OR" gate diode D6418. When the unit is in "Play," the appropriate choice of FG input signal from the "OR" gate is automatically selected by the logic circuit contained on this same board. The action of the circuit in this area being such that either transistor TR 6405 is driven into conduction or transistor TR 6406 is conducting, making the appropriate choice of FG signal available to the standard-time generator and logic gate.

SP/LP Auto Select Logic

The logic circuit used to sample the control track and control the SP/LP operational modes is fairly sophisticated as can be seen in Figure 31. Basically, two transistors (TR 6402 and TR 6403) are connected in what is known as a "set/reset flipflop." This term means that when the FF (flipflop) is triggered into one mode, it will remain so until it is triggered into the opposite state. Notice in the drawing, the output of this circuit is a line which is designated as "LP high" — TP 6406 voltage. This line is applied to a pair of "OR" gates consisting of diodes D6408 and D6409, and D6410 and D6411 respectively. Outputs from these gates ultimately drive two switching transistors designated TR 6405 and TR 6409.

During "LP-Record" mode, +12 volts applied to the base of transistor TR 6406 (via logic diode D6409) causes this device to saturate. This action shorts out the FG signal available from amplifier transistor TR 6411 and forces the FG input to the standard-time generator to be that obtained from the extra stage of frequency division in IC 6403. This action also cuts off switch transistor TR

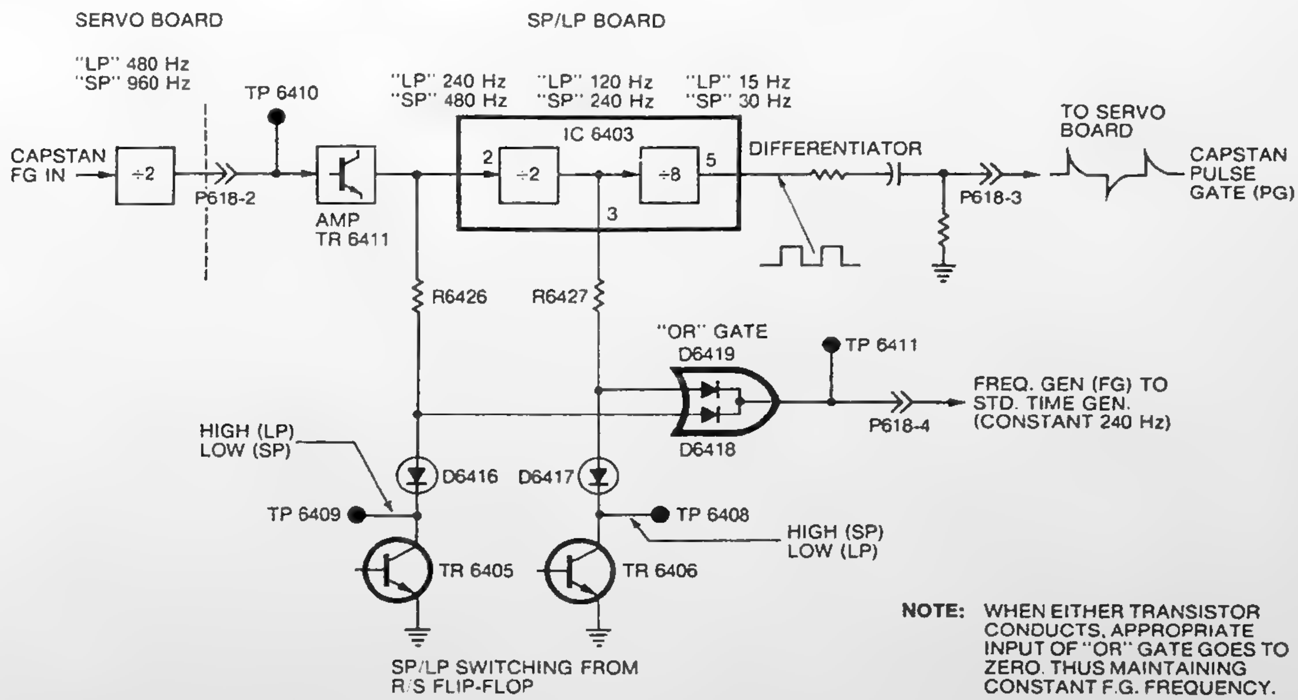


Figure 30. SP/LP Capstan Speed Selector

SP/LP AUTO SELECT CIRCUITS (continued)

6405 causing its collector voltage (TP 6409) to go high (+12V) providing sources of voltages designated **"video LP high"** and **"audio LP high"** to become available at P619-5 and P619-6. These voltages are routed to the Luminance Process board and the Audio board respectively.

When in the "SP-Record" mode, switch transistor TR 6406 is turned "off" and switch transistor TR 6405 is thus saturated driving the TP 6409 "LP-high" line to the **low** (0V) logic state. At the same time, diode D6416 shorts the signal obtained directly from transistor TR 6411 making the FG signal available to the standard-time generator that was obtained from the extra stage of frequency division in IC 6403.

In "Play," the operating mode is determined by the "LP-high" output of the R/S flipflop — DC voltage at TP 6406. As shown in the drawing, this voltage is **high in the LP mode** and **low in the SP mode.** Whenever the machine is in the LP mode of operation, the output of the R/S FF is **high** at TP 6406. Under these conditions, bias voltage is applied to the base of switch transistor TR 6406 via "OR" gate diode D6408. Now, switch transistor TR 6405 is cut off and the proper conditions necessary for LP operation are established. Conversely, when the machine is in the SP mode of operation, the flipflop output is **low** at TP 6406 and switch transistor TR 6406 is cut off. Under these conditions, necessary SP mode conditions are satisfied.

The remainder of the circuitry on this simplified schematic (left side) is dedicated to controlling the state of the R/S flipflop. Notice that two input lines control the flipflop. These are designated "set" (S) and "reset" (R). When the machine is operating in the correct mode (playing back tape correctly), signals are not present on either of the control lines. In the event of an error condition, a pulse voltage appears on either the (S) or the (R) line which causes the flipflop to switch to the other state and set up the necessary conditions for the proper Playback mode.

For example, if the machine is running too slow (such as if the machine was running in the LP mode, but the tape to be played back was an SP recording), a pulse will appear on the FF (S) line (TP 6407) which will cause the flipflop to be driven to the opposite state to establish the SP Playback mode. The opposite error condition (LP recording with machine in SP speed mode) will cause a pulse to appear on the (R) line (TP 6405) which will cause the machine to enter the LP operational mode. The actual pulse that is used to set or reset the flipflop is produced by transistor TR 6401 (differential pulse amplifier — DPA). The base of this device is timed by the control-track signal after it is processed by a pulse clipper stage contained in IC 6401 and a "T-type" flipflop. (A T-type flipflop is an IC device — IC 6402 — which changes state every time it is triggered. Thus, the device acts as a ÷ 2 counter.)

As can be seen in Figure 31, (normal operation), the 30-Hz control-track signal at TP 6401 triggers the "T" flipflop to change state on the leading edge of the control-track signal. Thus, the output of the "T" FF is a 15-Hz squarewave which is viewable at TP 6402. The leading (rising) edge of the "T" FF (TP 6402 signal) triggers a monostable, or one-shot multivibrator, which has a conduction period of approximately 25 ms. This multivibrator, designated as "MM 1" in IC 6401, produces a trigger for a second monostable, one-shot designated as "MM 2." Notice in the timing diagram that the second one-shot triggers on the rising edge of the MM-1 signal. The period of this one-shot is also 25 ms. These two signals are combined in a logical "AND" function by diodes D6406 and D6407. This output is then connected in another logic "AND" configuration to the collector of TR 6401 (DPA). Thus, the DPA pulse is prevented from triggering the R/S flipflop except in intervals of time when both diodes D6406 and D6407 are reverse biased due to both one-shot multivibrator outputs being in the logic **high** states. This condition only occurs in the event of a speed error which is causing the machine to run slow.

The logic necessary to control the "set" (S) line of the R/S flipflop is provided by taking output signal from MM 1 and inverting it in transistor TR 6404. The output of inverter transistor TR 6404 is utilized in a logical "AND" configuration with the DPA signal via diode D6404. As can be seen in the timing diagrams, a pulse from the DPA to set the flipflop via TP 6407 is only available under conditions when the capstan motor is running too fast. Application of this pulse then changes the state of the flipflop and causes the machine to enter the LP mode of operation which is necessary to restore correct frequency to the control-track signal.

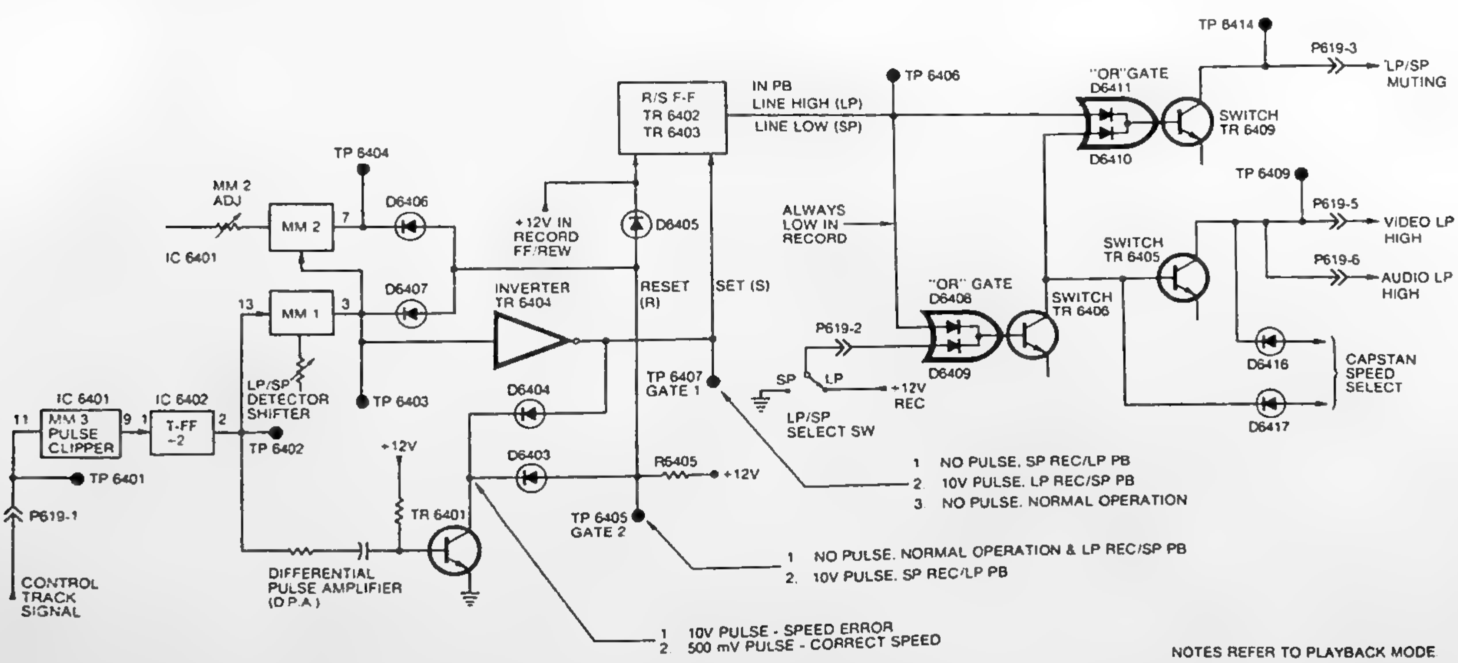
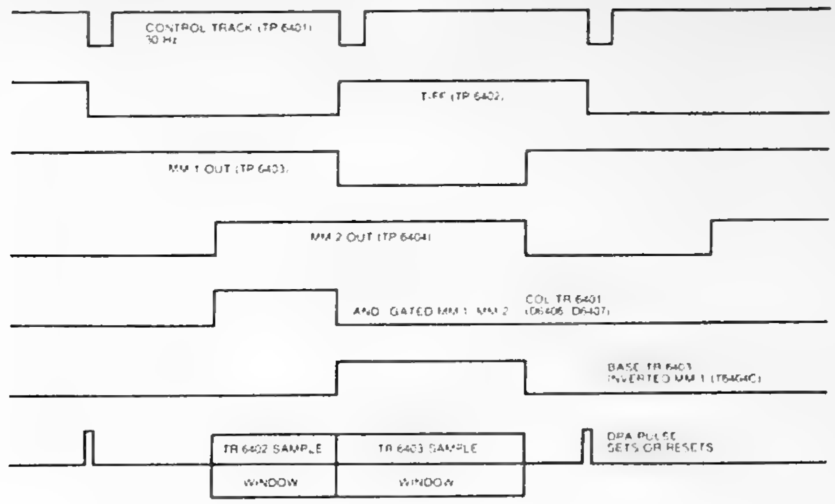


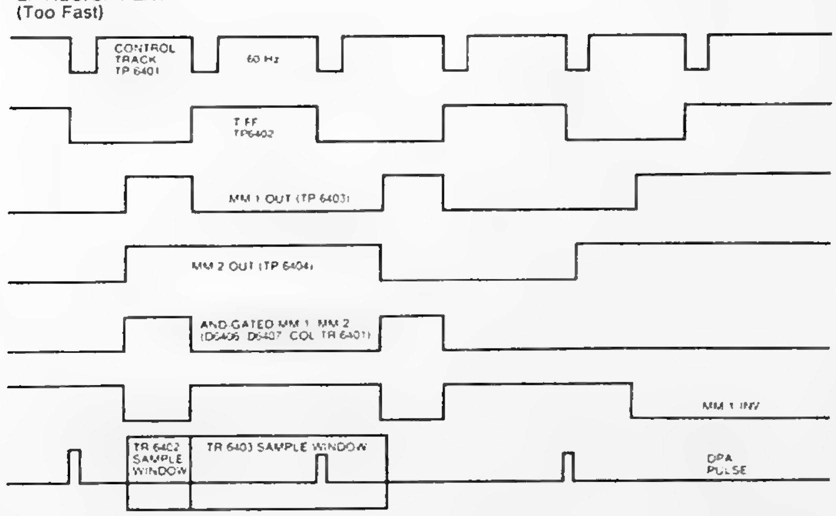
Figure 31. SP/LP Auto-Select Circuitry Block Diagram

SP/LP AUTO SELECT CIRCUITS
(continued)

SP REC/SP PLAY OR LP REC/LP PLAY
(Normal Operation)



LP REC/SP PLAY
(Too Fast)



SP REC/LP PLAY
(Too Slow)

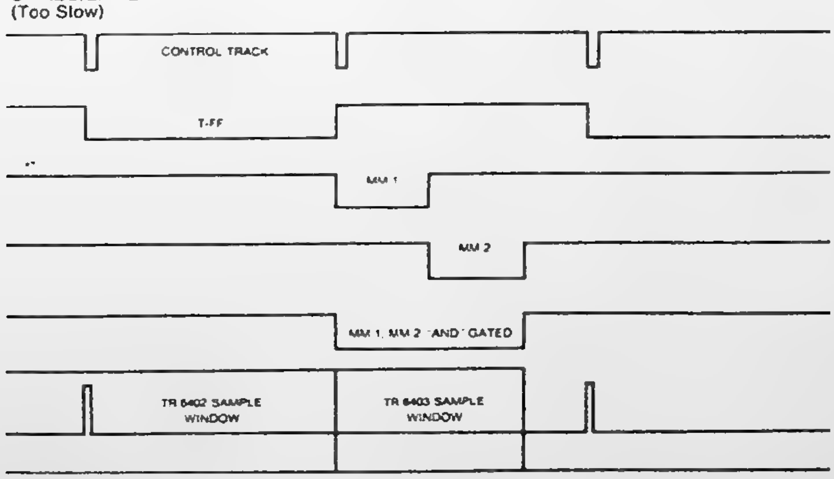


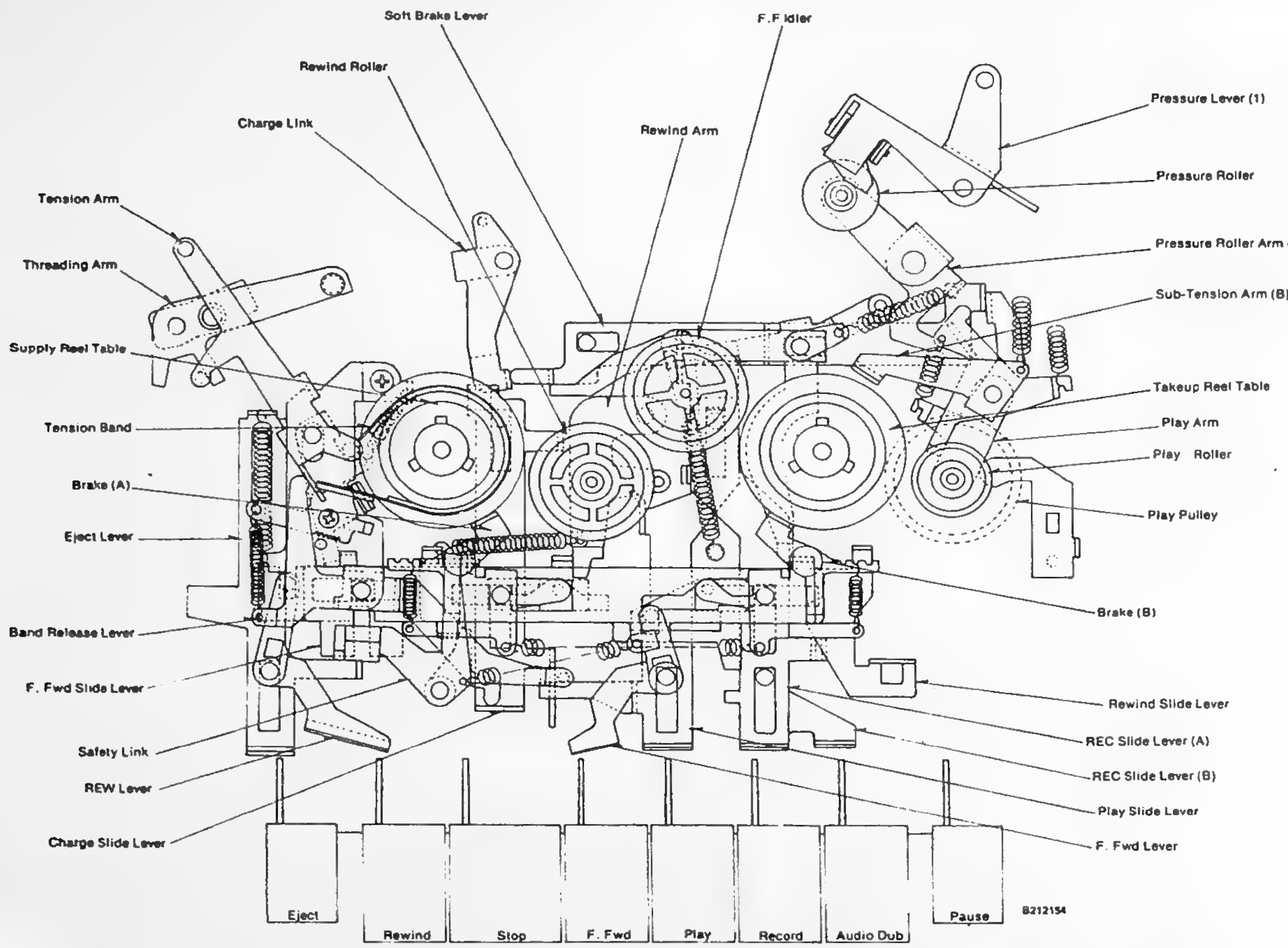
Figure 32. SP/LP Auto Select Timing Diagrams

MECHANISM OPERATION

The mechanical operation of the VBT200 Video Cassette Recorder is comparable in many respects to an audio cassette recorder mechanism. Tape is moved through the mechanism by a servo-controlled capstan drive system. A principle advantage of the VHS tape system is the simple and direct-routed tape handling system. The simplicity of the VBT200 mechanism will be particularly appreciated by the service technician. As a further assist to servicing, the following operational mode descriptions and drawings should be helpful when troubleshooting mechanical problems.

Stop Mode

When mechanism is in "Stop," and no drive is applied to the supply or takeup reel turntable, brakes "A" and "B" are applied to prevent rotation of either turntable.



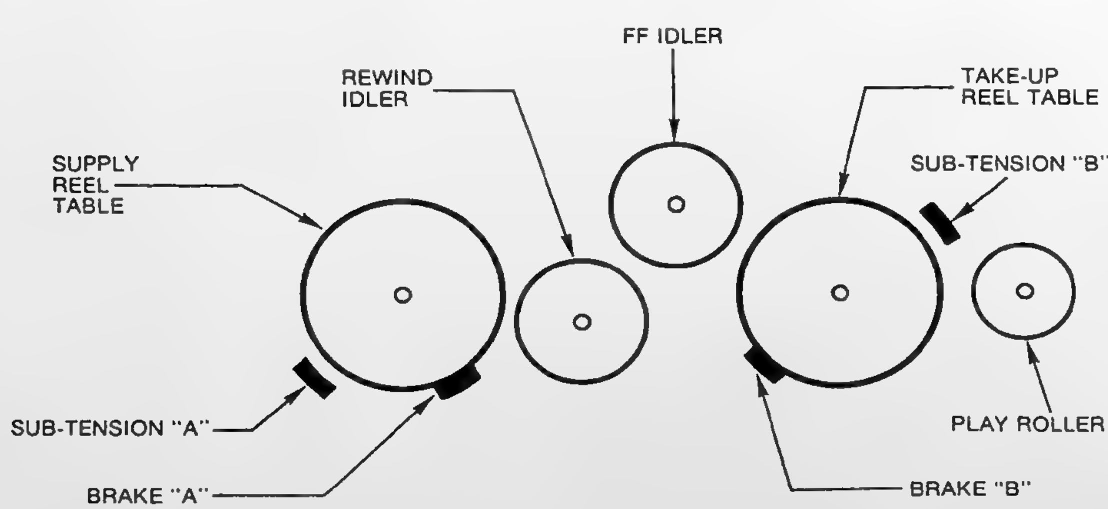


Figure 33. "STOP" Mode Operation

MECHANISM OPERATION (continued)

Play Mode

In "Play," brakes "A" and "B" are released, and the Play roller contacts the takeup reel turntable and drives it through a friction clutch on the bottom of the play roller assembly. In this way, constant takeup tension is maintained on the tape so that it winds smoothly into the cassette.

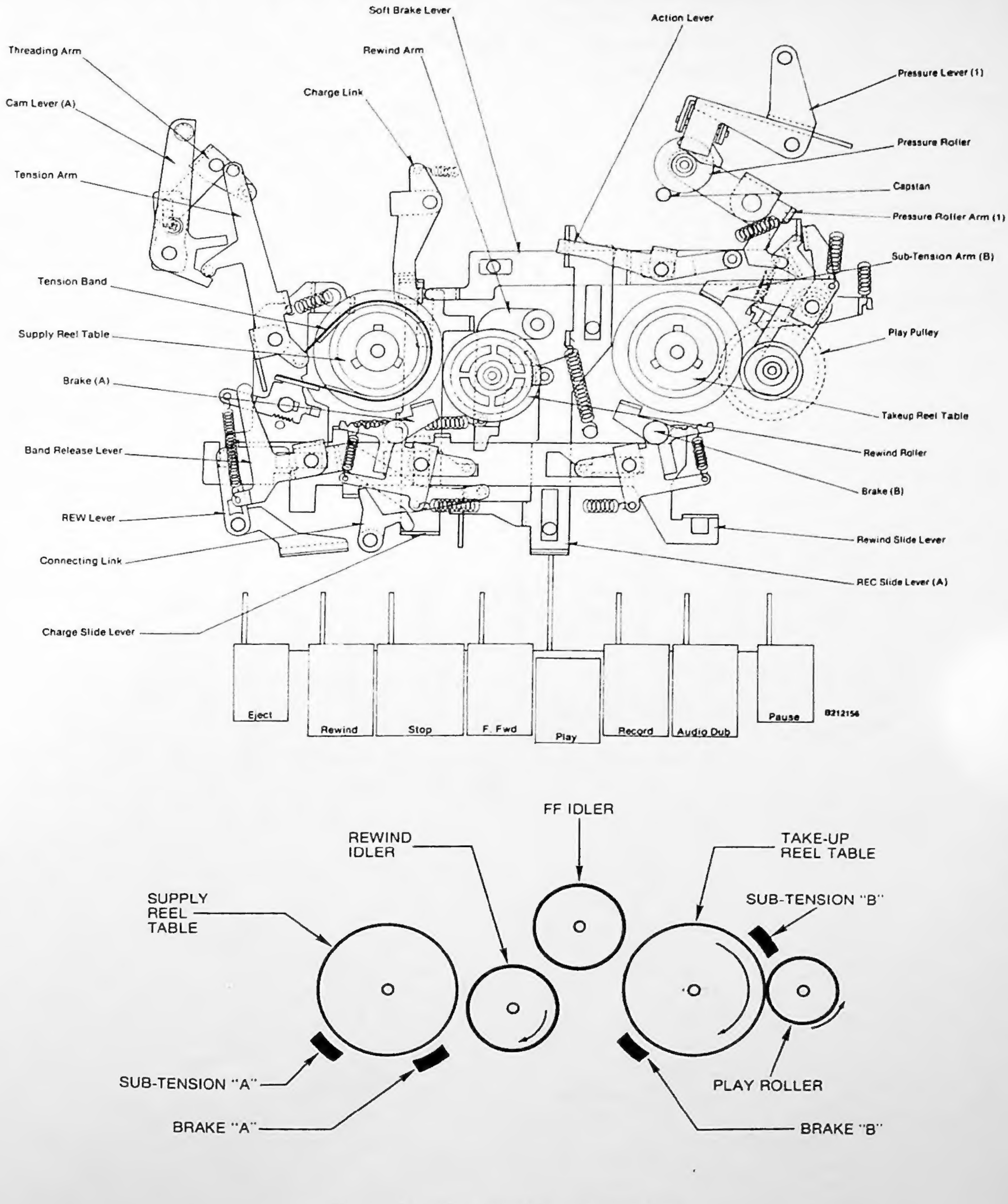
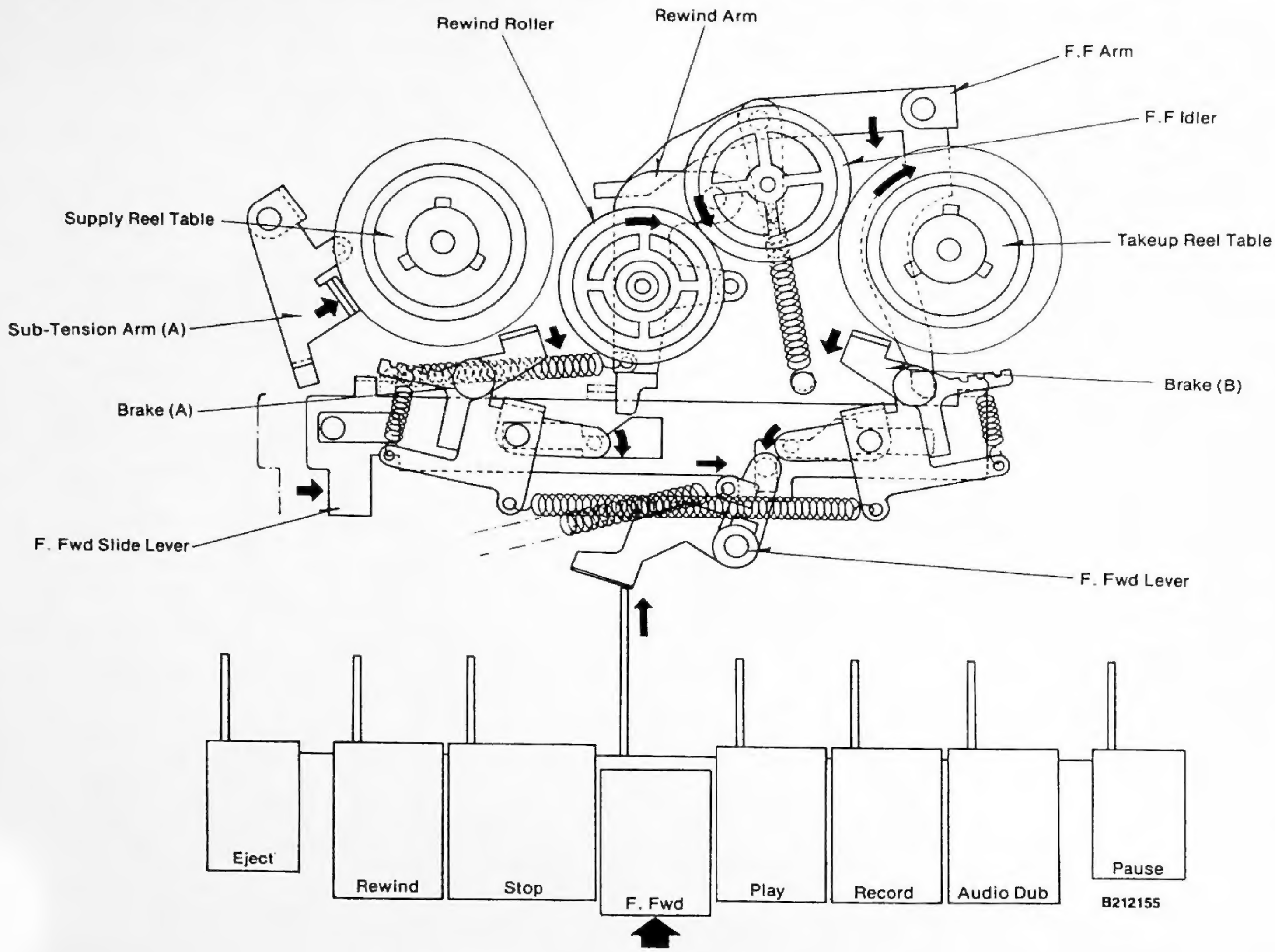


Figure 34. "PLAY" Mode Operation

MECHANISM OPERATION (continued)

Fast Forward Mode

When the unit is in Fast Forward, brakes "A" and "B" are released, and power is applied to the takeup turntable from the rewind idler via the fast forward idler. In this manner, the takeup turntable is driven at a speed which allows a full VK 250 (2-hour/4-hour) cassette to run through the machine in less than 4 minutes. Tape tension is maintained during the Fast Forward mode of operation by subtension brake "A" which applies braking to the supply reel turntable so that back tension is maintained on the tape; thus, the tape winds smoothly on the takeup reel turntable.



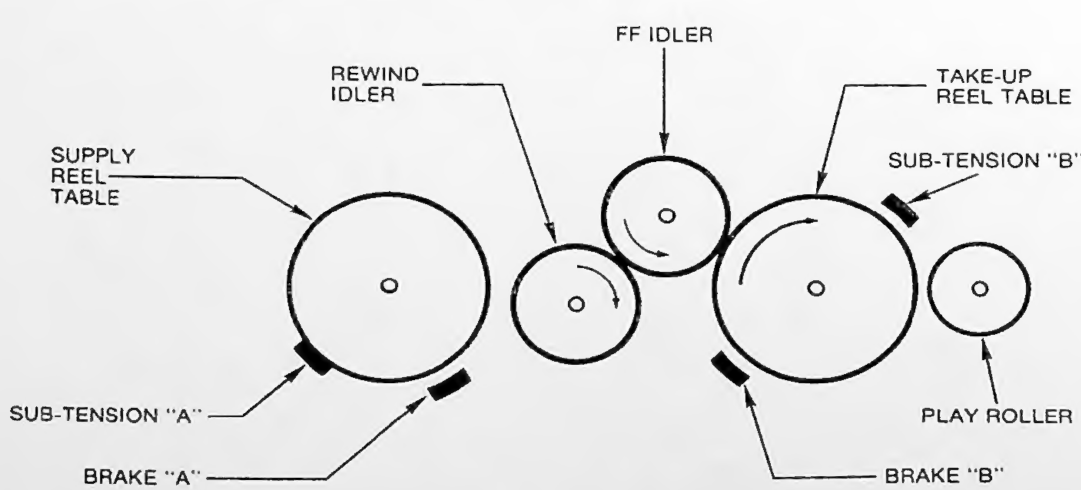


Figure 35. "FAST FORWARD" Mode Operation

MECHANISM OPERATION
(continued)

Rewind Mode

Rewind operation is similar to Fast Forward except the rewind idler directly drives the supply turntable. No subtension braking is required in Rewind due to the back tension provided by the drag of the reel stop sensor and counter assemblies.

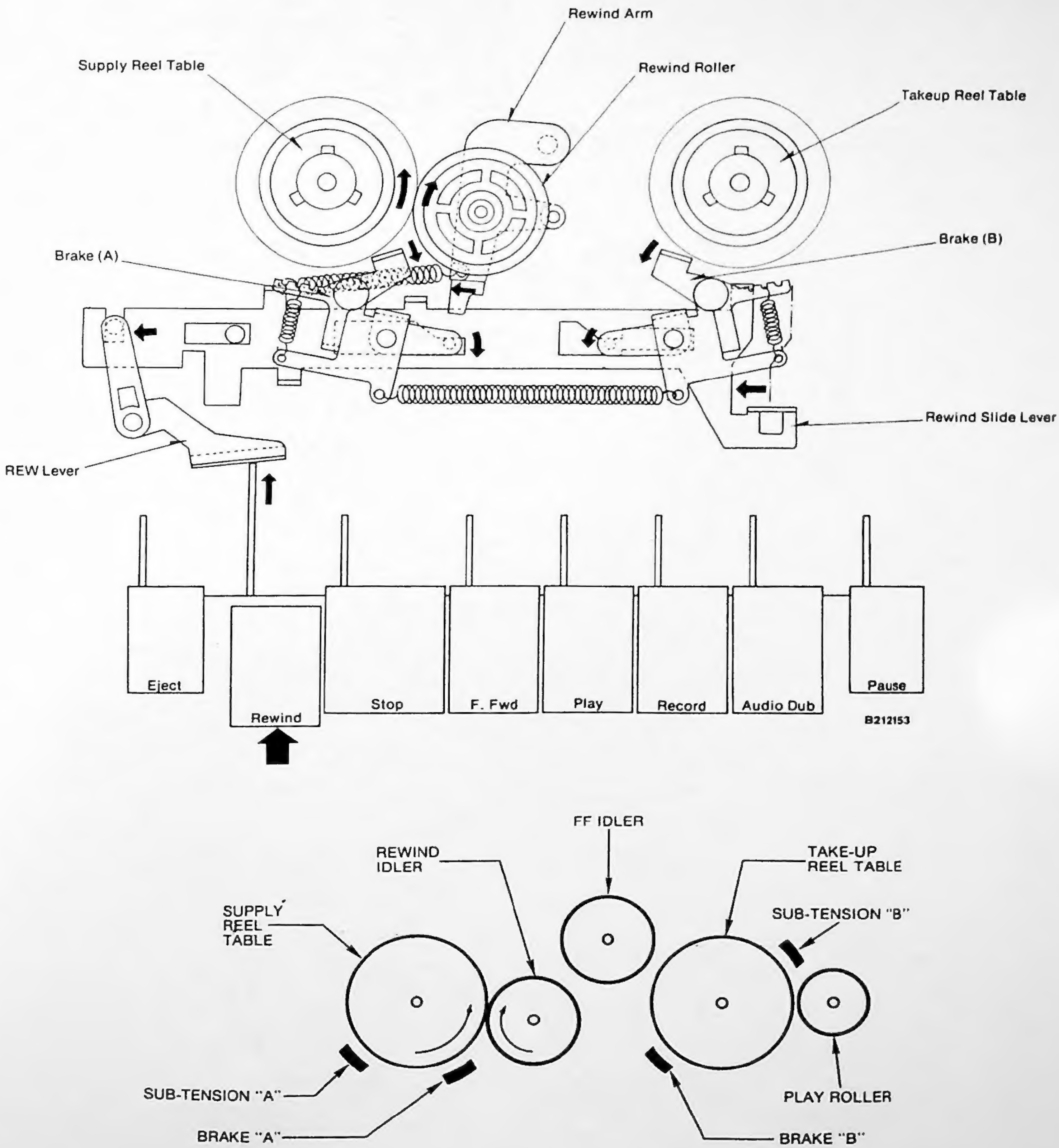


Figure 36. "REWIND" Mode Operation